Citizen Science Toolkit Conference

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from citizen science to policy and planning: examples from the united kingdom

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Note that this document did not originate as a formal paper. Rather, it combines an oral presentation with accompanying PowerPoint slides and reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

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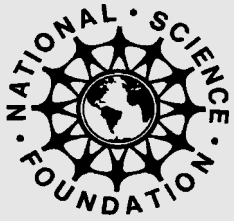
The following is the opening talk of the session titled "Impacts of Citizen Science" on day two of the Citizen Science Toolkit Conference



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From Citizen Science to Policy and Planning: Examples from the United Kingdom

Stephen Baillie,
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Introduction

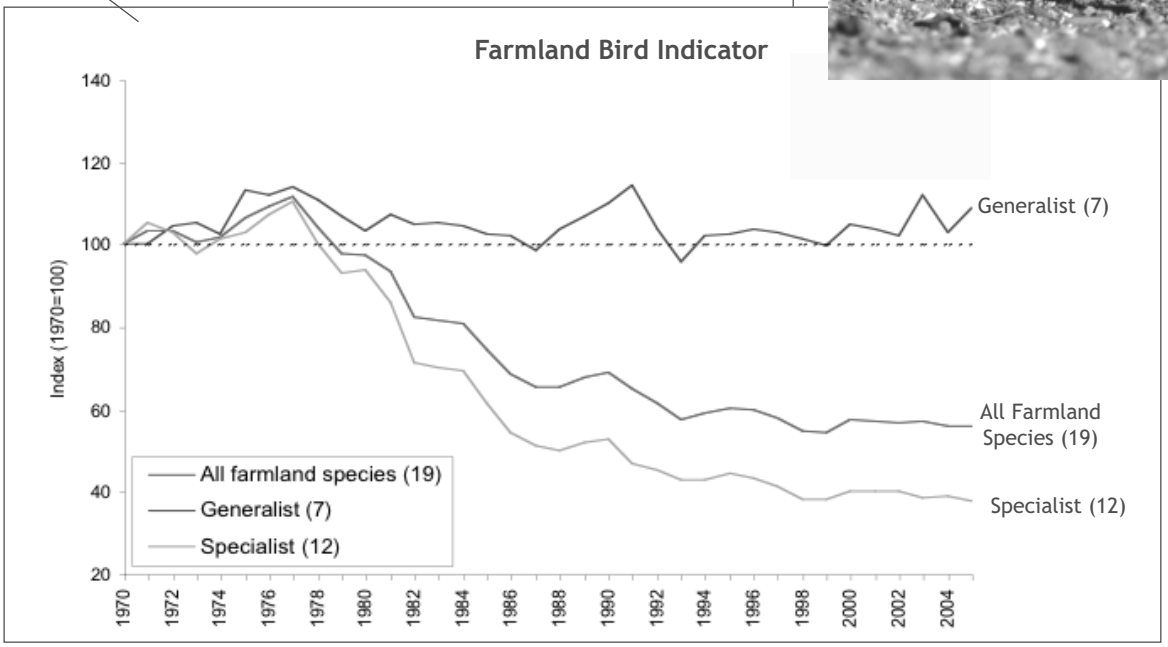
Thank you for inviting me to this workshop. It is a privilege to be here and I have enjoyed very much talking to all of you about your citizen science projects and learning lots of new ideas about how we can develop better volunteer surveys.

What I want to talk to you about this afternoon is a couple of examples of how research and monitoring undertaken by the British Trust for Ornithology (BTO), based very largely on volunteer surveys, has had an important input to conservation and environment policy in the U.K. The first example involves work on the conservation of farmland birds and secondly, a bit more briefly, I'll say something about our recent work on Avian Influenza.

www.bto.org

Farmland Birds

This graph shows the Farmland Bird Indicator for the U.K. This is an indicator that has been adopted by the government and is a simple summary of trends of farmland birds, which is the logarithmic average of the population changes. You can see from this graph that farmland birds declined quite severely in the U.K. from the 1970s through to the mid-1990s. You can also see, if you look in a little



more detail, that the specialist farmland birds have declined really quite severely, but the generalist species contained in this list haven't declined.

I want to talk first of all about how we generate this index and how it has become important as a measure for government policy on farmland bird recovery. The underlying data gathering scheme for this is the BTO/JNCC/RSPB Breeding Bird Survey, which we started in 1994. It replaced the previous spot mapping survey called the Common Bird Census. I'm not going to go into the details of what we've done, but will say that we have been able to calibrate these two surveys. Through some fairly elaborate analyses it is possible for us to produce joint trends going back to the 1960s, based historically on the Common Bird Census and, since the 1990s, on the Breeding Bird Survey.

The Breeding Bird Survey now encompasses about three thousand sites as you can see from this map. It uses a line-transect method.

The Breeding Bird Survey

BTO/JNCC/RSPB Breeding Bird Survey (BBS) is the UK's main survey for monitoring the changing numbers of our widespread breeding bird species.

The BBS was launched in 1994 and replaced the Common Bird Census (CBC) after 2000.

BBS is a UK-wide mass-participation volunteer survey.

Organized by the BTO and funded by BTO, JNCC and RSPB.

BBS

BTO | JOINT NATURE CONSERVATION COMMITTEE | RSPB

Sites Included in Analysis

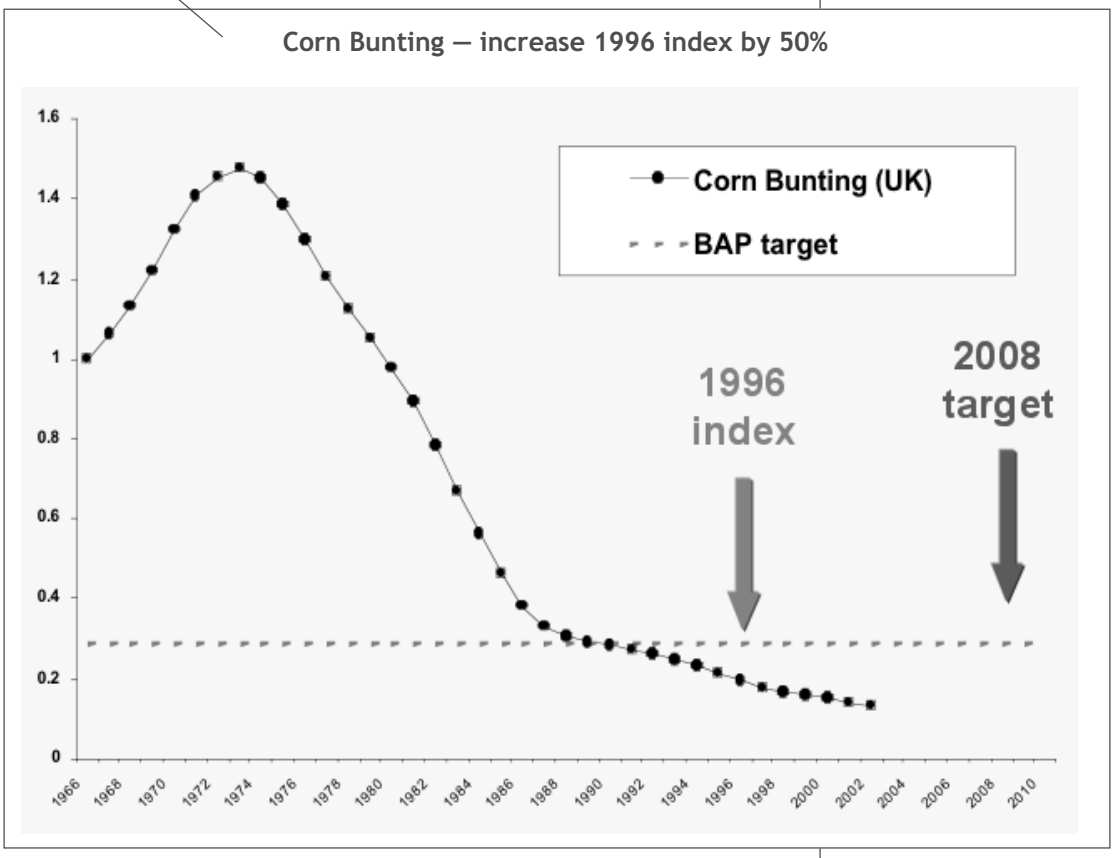
- The BBS uses a line-transect method of sampling bird numbers.
- BBS observers count all the bird species they see and hear along a 2km transect route, within a randomly selected 1-km grid square.
- Quick and easy methods (5-6 hours of fieldwork per year) enable a large number of sites to be surveyed (2,879 in 2005).
- Squares surveyed in two or more years are included in the production of trends (3,366 squares in 2005).
- Results take account of different coverage intensities across the UK.

Virtually all of these surveys are undertaken by volunteers. In a few years we've supplemented their efforts by a very small amount of professional field-work, but essentially it is a volunteer-based survey and it is rigorously designed. It was developed to improve our survey coverage and to remove some

shortcomings from the Common Bird Census.

Observers count the birds in a one-kilometer square by walking a two-kilometer transect route. The methodology is quick to apply, and observers need to make just two visits to their square each year, or perhaps three if they choose to do their habitat recording separately. Squares included in two or more years can be used for the trends index. One important thing to point out here is that we have a formal, stratified sampling design, and it is stratified by potential observer density. This means that we can use all of the observers that we can find in southern England, but we can still get representative trends from the whole country by appropriately weighting the analyses.

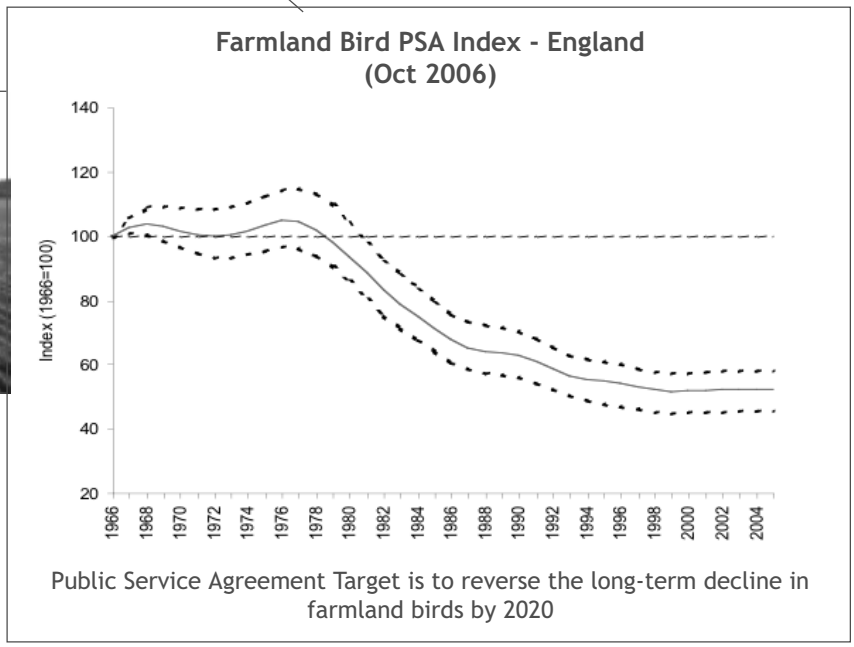
This is an example of the type of trend for a single species.



We use generalized additive models to calculate the smoothed trends. By doing this we are taking out short-term variations, for example due to short-term fluctuations in the weather, and arrive at a summary of the long-term trend. This particular graph shows a target for the recovery of this particular species, the Corn Bunting, which is one of the bird species that has declined most severely.

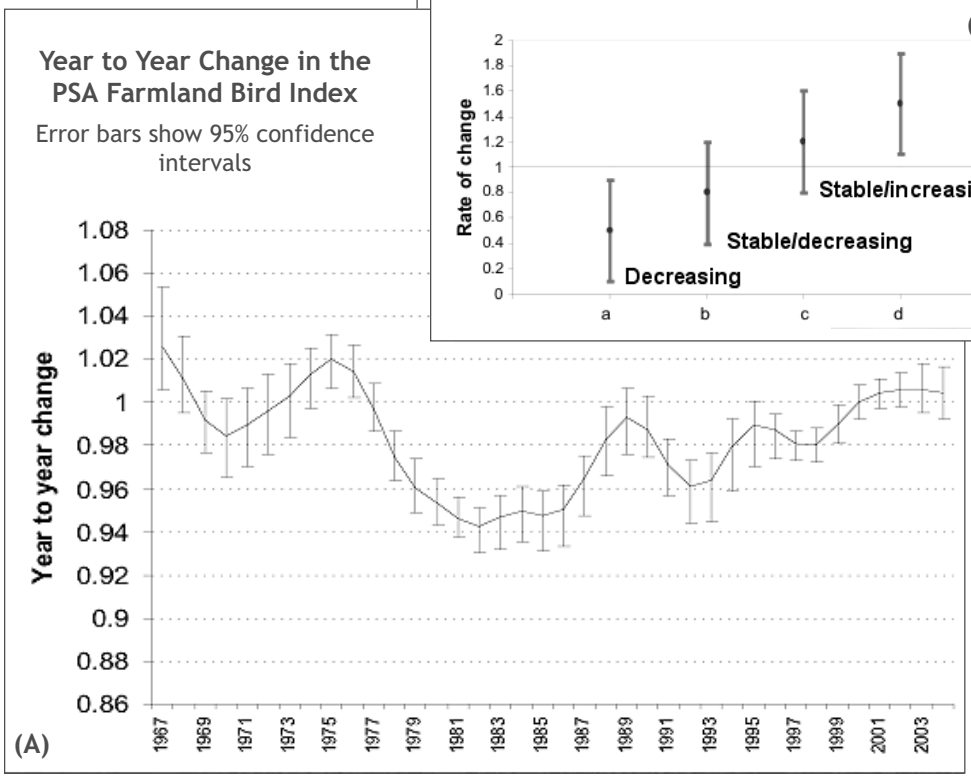
As a result of the declines in farmland birds and discussions with conservation organizations, the U.K. government has decided that it is important to achieve recovery of farmland bird populations. They

have agreed on a high-level government target, what is called in our country a Public Service Agreement Target, to reverse the decline in farmland birds by 2020.



Public Service Agreement Target is to reverse the long-term decline in farmland birds by 2020

I'm now going to talk about the mechanisms for this because if you're going to have a target, the first thing you've got to be able to do is to agree what you're measuring in terms of recovery. It was decided that what would be used for measuring this was a smoothed version of the Farmland Bird Index. So this is just like the Farmland Bird Index I showed you before, except this generalized additive modeling has been used to produce a smoothed trend, so we don't get to worry about short-term fluctuations.



What we are looking for is to see that the trend has been reversed and that we have a significant upward trend rather than a significant downward trend. The overlay graph (B) shows the agreed criteria that are used to make this assessment. What we're looking for is a contin-

ued period of significant increases that will indicate that the target is being met. If you look at the main graph (A) you can see that the situation got worse through to about the mid-1980s, and since then it has been improving. However, we're still in a situation where the population has been declining. Thw graph shows that we haven't yet reached a satisfactory position, but the rate of decline has at least slowed and hopefully we are moving towards an increasing trend in the future.

The monitoring being done by volunteers through a structured, well-designed survey program has been essential both for identifying the problem and for setting a target for population recovery. But this doesn't help if you don't know how to get there. The next thing you need is more detailed information about management of the populations and their habitats in order to work out what measures need to be taken to achieve farmland bird recovery.

My colleagues in the BTO's Terrestrial Ecology Unit have this as a major focus of their work. The solutions are often species-specific or situation-specific. Let me give you a couple of examples to give you a flavor of these sorts of studies and to show the power of a combination of volunteer-based surveys and intensive professional work. We need to understand enough about how birds are using farmland habitats to be able to design effective agri-environment schemes that have some hope of bringing about farmland bird recovery.

Birds & Stubbles

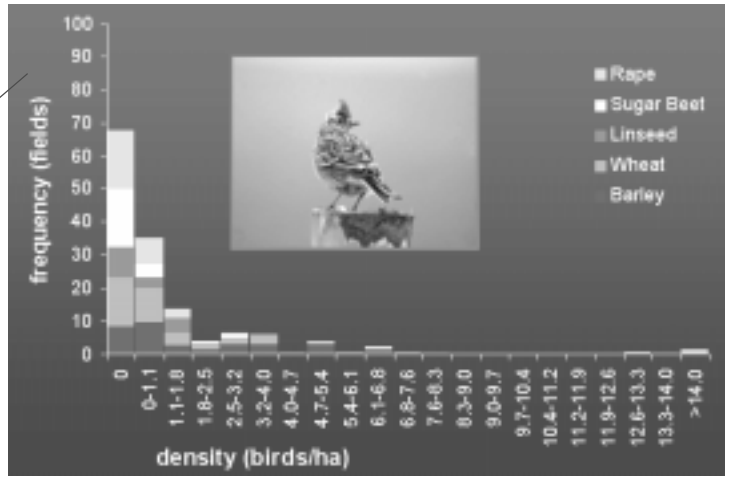
National Context
1017 1-km squares covered for Winter Farmland Bird Survey

Intensive Study
122 fields surveyed in Breckland, East Anglia

In this case we're looking at birds in stubbles, which are an important food source for birds in the winter. We're looking at results from a national, one-off survey of winter farmland birds carried out over two or three seasons, involving volunteers surveying over 1,000 one-kilometer squares, combined with a more intensive study to look at the feeding biology of the birds.

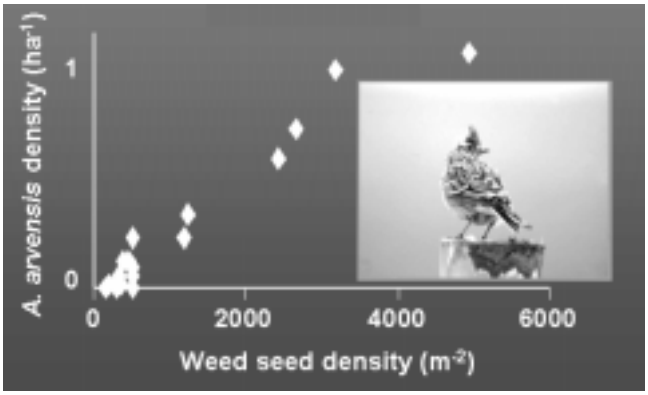
The extensive survey provided information on the densities of birds occuring in different field types. On the far left you can see that the first bar, which is by far the tallest bar, is zero density, so most fields don't have any Skylarks feeding in them in the winter. There is a scattering of a relatively smaller number of fields that do have some birds feeding.

Frequencies of mean Skylark densities



Vickery et al. in review, *Jnl Appl Ecol*

Alauda arvensis numbers & weed seed density on farmland in winter



Robinson et al. *Jnl Appl Ecol*. 2001

The next graph shows results from the intensive study where professional field workers measured individual seed densities. There is indeed a strong relationship between weed seed density and bird density that helps us to explain the pattern of variability in farmland bird abundance between fields. Further work also showed that variation in weed seed density, in turn, is determined largely by the amount of herbicide applied to each field. So we've got quite a good understanding of how the winter food for these birds is being determined by particular agricultural management practices, and can then start to think about how to design agri-environment schemes involving combinatons of practices that will reverse that situation and increase the winter food supply for these birds.

Another question we need to look at is whether management in the winter is actually affecting the abundance of breeding birds. This was done by combining information from the Winter Farmland Bird Survey and the Breeding Bird Survey. So we're now looking at combining two different extensive volunteer-based surveys to get at another part of the jigsaw.

Birds on Stubbles

79% of the variation in mean density of seed-eating finches, buntings and sparrows (expressed as energy demand) can be explained by variation in weed seed density and chemical management regime in the preceding crop.

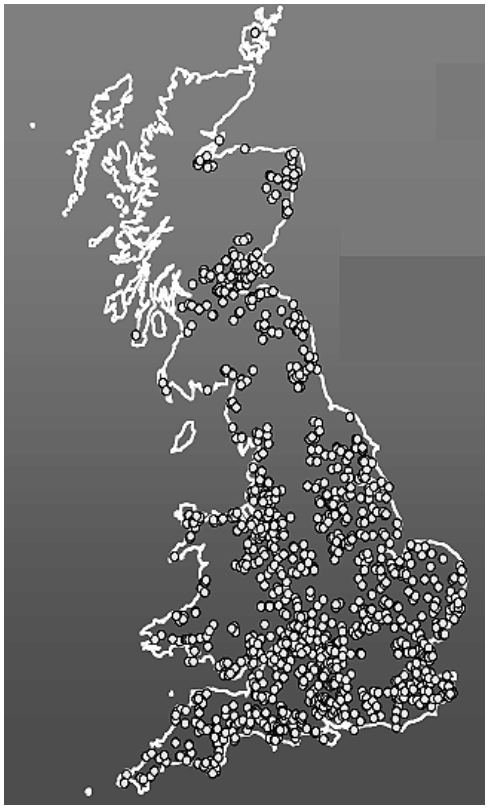
Birds on Stubbles

Winter Farmland Bird Survey (WFBS)

1017 1-km squares covered over three winters (1999/00 to 2002/03)

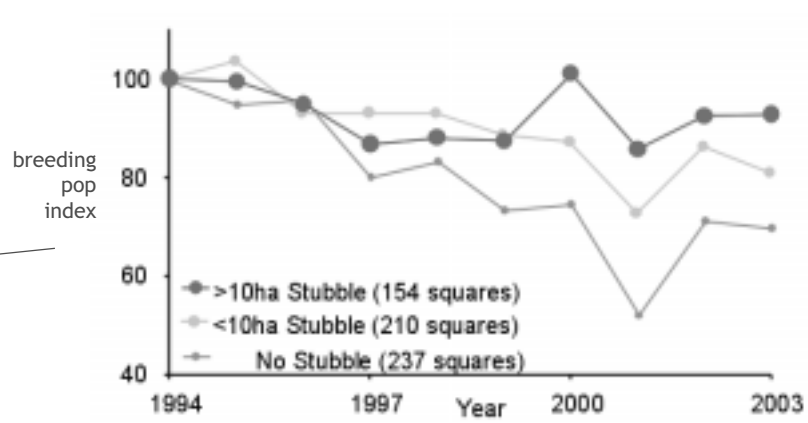
Breeding Bird Survey (BBS)

600 of WFBS surveyed for breeding birds 1994 onwards



The project team used information from the Winter Farmland Bird Survey on the amount of stubble that people had observed. They recorded habitat data as well as bird data. Then they used the Breeding Bird Survey to measure the changes in breeding populations. They found that where there was no winter stubble, there were declines in Skylarks; where there was a small amount of winter stubble, decline was reduced; and where there was a large amount of winter stubble, the population was almost stable. This is an indication that the winter conditions on the ground are actually affecting the breeding populations, which is where we want to achieve and measure farmland bird recovery. If we can achieve more stubbles, then we could expect an increase in these populations.

Skylark breeding population trends



GLM, Likelihood ratio test $x^2_1 = 18.3, P < 0.001$

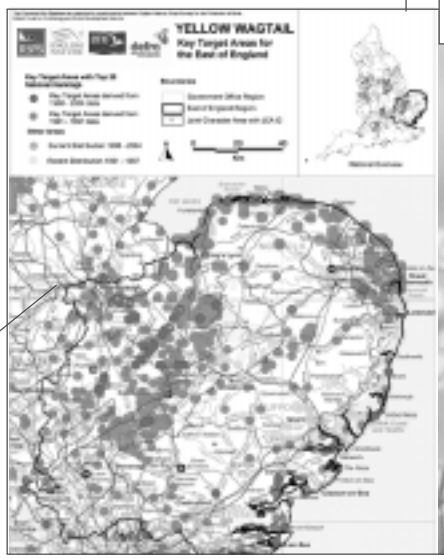
Gillings et al. *2005 Proc Roy Soc B 272, 733-739*

In an earlier discussion, the question came up: Are good quality journals accepting citizen science results for publication? These particular results were published in the *Proceedings of the Royal Society*, which is one of the most prestigious scientific journals in the U.K. I think that very much indicates that data from citizen science, from volunteers, can provide high-quality data leading to high-level scientific publication as well as to valuable conservation applications. But to do this it is usually necessary for the study design and analysis to be the responsibility of professional ecologists.

Another input to this whole process has been to identify areas for particular species in which there are concentrations of species where particular agri-environment measures need to be targeted. This is a slightly less rigorous type of information. Here we're simply looking to collate all of the information on concentrations of birds and use this to inform some detailed planning on agri-environment measures on the ground. This is something called the Farmland Bird Database and we can use BirdTrack, which is our version of eBird, as a key source of informa-

Farmland Bird Database

Collates national, regional and local datasets to determine current distribution and hotspots for targeting the Higher Level agri-environment Scheme (HLS)

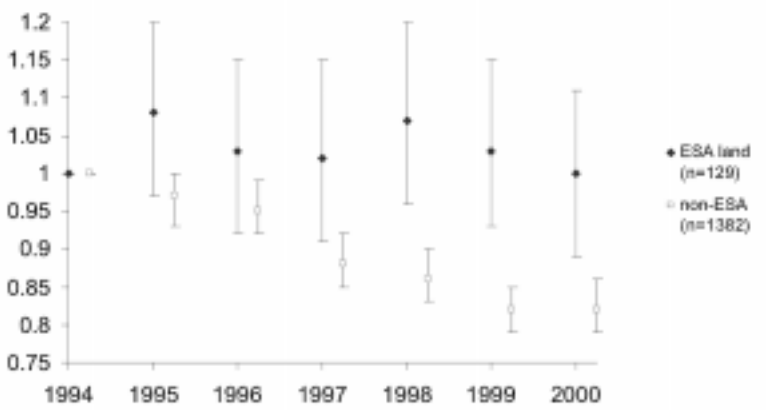


www.birdtrack.net

tion to feed into this project. We've got bird watchers going all over the country collecting lists and feeding them into BirdTrack (to fulfill a range of objectives). This is less rigorous information than the Breeding Bird Survey, but we can still make use of it for this particular objective of conservation targeting.

Finally, we need to accurately assess whether large-scale agri-environment schemes are successful in terms of bringing about the farmland bird recovery that we're looking for. Two years ago the UK Government started a really major scheme (the Entry Level Scheme — ELS) that is expected to involve a high proportion of farmers and will be a key mechanism for reversing the declines of farmland birds in the wider countryside. The example below shows that within Environmentally Sensitive Areas, which were smaller areas with special management prescription, Skylarks did better than outside those areas.

BBS indices for Skylark in England & Wales: within and outside Environmentally Sensitive Areas



Squares selected were on lowland farmland in England— arable or pastoral dominated. In 2005 almost 1000 squares were surveyed by a team of ca 24 professionals, and almost 1500 by BBS volunteers.

Additional Survey Squares
975 red dots [dark gray]

BBS Squares
1474 green dots [light gray]

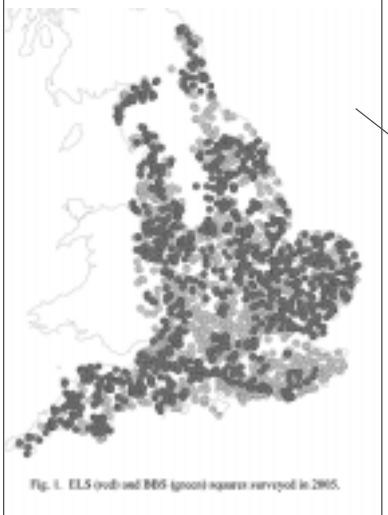


Fig. 1. ELS (red) and BBS (green) squares surveyed in 2005.

In 2005 we undertook the first large-scale bird monitoring of the Entry Level Scheme. For this we used a combination of professionals and volunteers. We don't actually have enough volunteers to provide all of the coverage we need for this, so we are combining volunteers and professionals, both essentially doing the same survey and generating the same quality of data in order to provide the enhanced coverage that we need to assess ELS. We plan to gather additional pulses of such information in 2008 and 2011, which will allow us to compare how the birds are doing inside and outside the areas covered by ELS and related agri-environment schemes. Hopefully, this will enable us

to assess and, as necessary, propose modifications to the recovery plan which is now being put in place.

This subject of farmland birds has been a big area of work for the BTO over quite a number of years. We are working closely with the UK Government's Department for Environment, Food and Rural Affairs (DEFRA) and with colleagues in the RSPB and in a number of other conservation bodies, including English Nature, the government agency which has now become Natural England, and with other similar organizations in Scotland and Wales. There has been a lot of interest in this topic and we now have quite a good understanding of what is happening. Volunteer surveys have played an enormous part in this. Indeed, without volunteer surveys we wouldn't have known about the problem and we wouldn't have been able to do much of the work necessary to develop solutions.

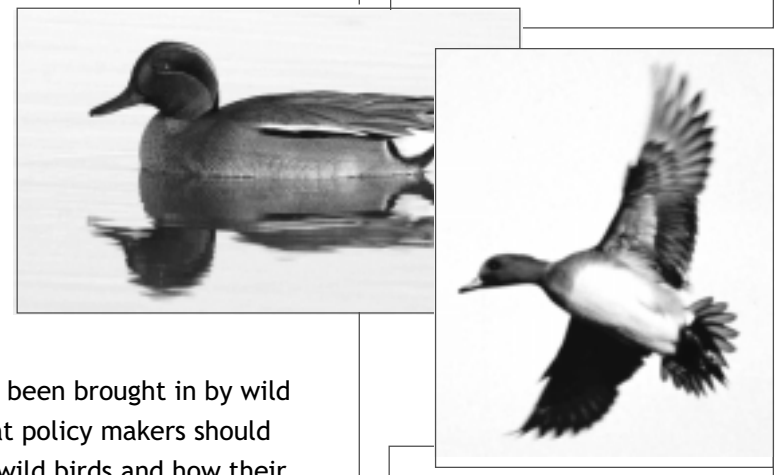
Following power analyses to assess the number of squares required to detect changes in numbers of 5-10% over six years, a survey focused on arable and pastoral landscapes was designed and undertaken in 2005. It will be repeated in 2008 and 2011.

Avian Flu

The second applied problem that has required a lot of attention from my team over the last two years has been the spread of Highly Pathogenic Avian Flu (HPAI). We've done two pieces of work using extensive data gathered mainly by volunteers to inform government policy relating to this issue. This is possibly a shorter term problem than the farmland bird issue, but it remains to be seen how things will develop. The concern is to identify influxes of HPAI into the UK (or other European countries), and to assist in the identification of the sources and routes of transmission of any outbreaks that occur. Our contributions are in the bird ecology area, though obviously there are some other important components of such work that require inputs from virologists, epidemiologists and veterinary scientists. Indeed, there are indications that in the one significant case when HPAI reached the UK, it may not have been brought in by wild birds. Nevertheless, it is very important that policy makers should have a proper understanding of the role of wild birds and how their ecology relates to issues of that of HPAI.

Determining priority areas for surveillance in Great Britain

Aim: To identify priority areas for surveillance in areas where domestic poultry are at greatest risk from incursion of H5N1 from wild birds.

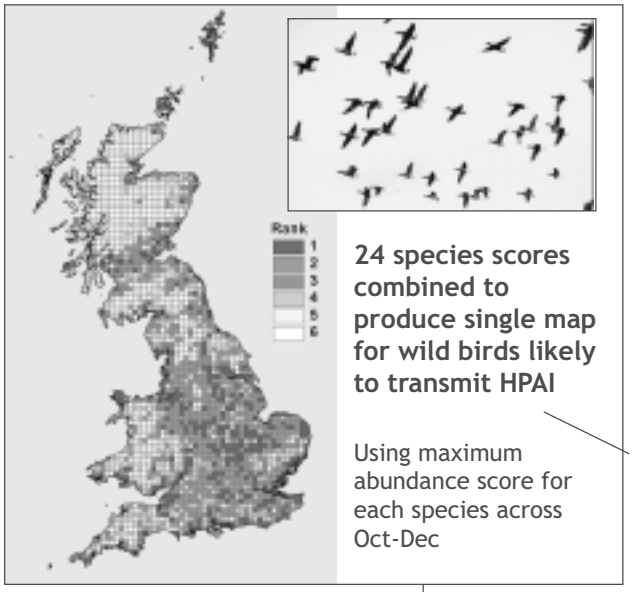


Areas requiring priority surveillance were based on the combination of:

1. Abundance of 'priority' wild bird species
2. Risk from a domestic poultry perspective

Based on data for 24 waterbird species

In response we have done two things. The first was to identify priority areas for surveillance because it wasn't possible to check every dead bird in the country for possible HPAI. The government wanted to know how they could target effort towards the areas where the disease is most likely to occur. This was considered to be areas where waterbirds, particularly migratory species, might potentially come into contact with domestic poultry.



24 species scores combined to produce single map for wild birds likely to transmit HPAI

Using maximum abundance score for each species across Oct-Dec

What we were able to do was to assess the abundance of priority wild bird species from our databases, use government databases to look at the distribution of poultry, and then combine the two to provide information on overall risk. We worked out maps combining data from various bird monitoring schemes. We were actually looking for up-to-date, qualitative, distributional information here, so we didn't have to rely on one rigorous scheme. We could pull in data from BirdTrack, from the Wetland Bird Survey, and from a lot of smaller projects that we have, and then we produced a combined map for the twenty-four species of interest.

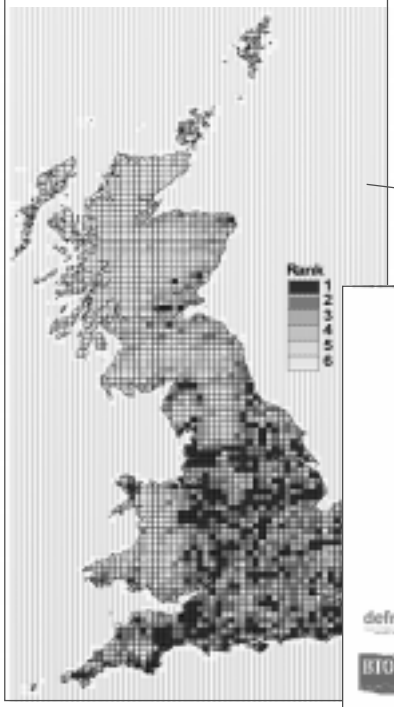
We then obtained a similar map from data on the distribution of poultry farms.

Each premises was given a score, based on e.g. number of birds, housing, breeding flocks, species, layer/broiler

Factors were summed across premises within 10-km squares

The two datasets were combined to give an overall risk.

The blue areas [darkest gray] have significant poultry populations (inc high number of free range flocks) **and** high abundance of priority wild bird species



Then these two datasets were combined to provide an overall indication of the areas at risk, so the darker areas on the map are the areas of greatest risk. Of course, even that is too detailed for policy implementation, as working at the level of ten-kilometer squares isn't practical. So what we then did was convert this to a summary based on government regions, which identified key areas where DEFRA made a particular point

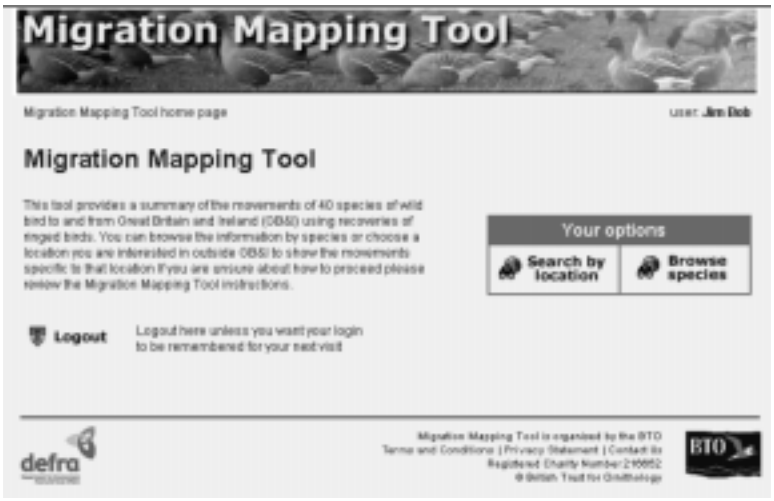
In practice…

These are the priority areas for collection of priority species of wild birds (gulls, waders, ducks, geese or swans)

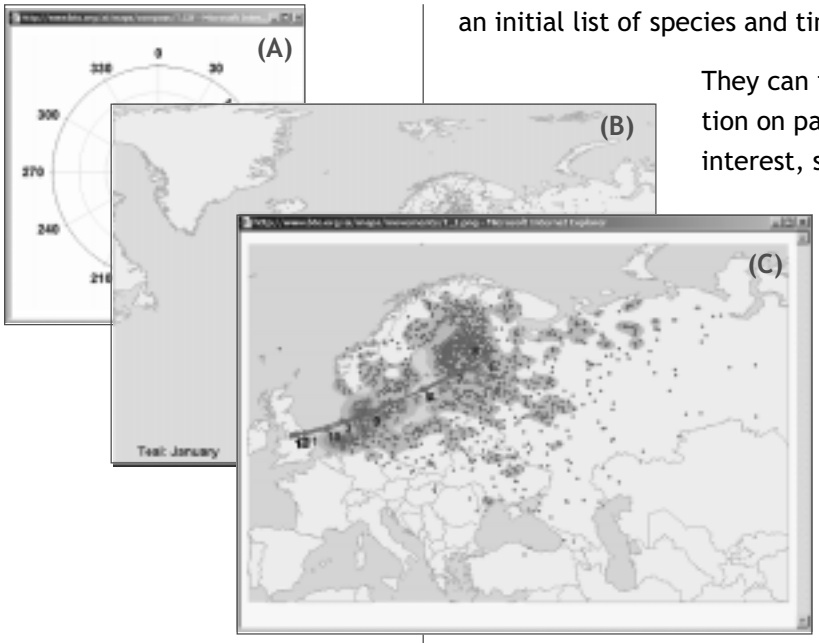
of having a focus on screening dead birds that were found for HPAI.

The second thing we've been doing, which is still very much a work in progress, is to develop a Migration Mapping Tool based on banding data. The large majority of banding in the UK is undertaken by highly trained volunteers. This ensures the safety of the birds and the integrity of the data, and gives rise to another very important and largely volunteer-generated database. What we've been doing is developing a Migration Mapping Tool as a first shot in assessing whether there are likely to be bird movements between a specific outbreak area on the continent and the UK. It could also be used to inform us about likely patterns of spread in the event of a series of outbreaks of HPAI occurring within the UK. We are currently working on a second version of the Migration Mapping Tool which will have wider European application as part of our work with the European Union for Bird Ringing (EURING), of which I am currently chair (www.euring.org).

Migration Mapping Tool
(Development)



The Migration Mapping Tool allows someone to enter the latitude and longitude to identify the area of interest, or they can use the Google Maps that I think everyone is now familiar with. This then gives them



an initial list of species and time periods that might be of interest.

They can then drill down further to view information on particular species for a particular area of interest, such as diagrams of distances and directions [*A*]. We've produced these dot maps of recoveries, but then we've also done a spatial analysis of these data to describe the kernel density where most birds are occurring [*B*]. [*In originalpresentation, the middle map in this series offered an animated view of the migration of Teal*.] You can see in this animation of Teal, which migrates to northern Russia in summer and then migrates south to western Europe in the Winter. Then we can also produce summary maps of average locations of the population at particular times of the year [*C*].

Obviously, this sort of information needs to be interpreted carefully for a variety of reasons, but nevertheless this Migration Mapping Tool, coupled with advice from our staff, will help to give decision makers a quick route to finding out what they need to know about when outbreaks occur in particular parts of Europe. And I'm sure you can see this sort of tool might also be very relevant to a range of other issues and problems involving bird movements.

Conclusion

I hope I've been able to show you that the types of data that we've been able to collect through volunteer networks are extremely relevant to conservation and environmental policy issues. I think it's possible to do good and rigorous science with these sorts of data. I commend the volunteers in our network, and in your networks as well, for the fact that they are able to collect high-quality data and often follow quite complicated protocols to generate data that are just as good as the data we would get if we sent professional surveyors out into the field. I think there's a great deal more that we can do with this data to address a range of applied issues, and also to test ecological ideas.

I'd like to end by again thanking the Cornell Lab of Ornithology and the organizers of this workshop for inviting me, and all of my colleagues listed here who have undertaken the work that I've been talking about today and provided me with some of the slides that I showed you. And finally, I would like to thank the volunteers, without whom we couldn't do any of this work.

Thanks to:

The Cornell Laboratory of Ornithology, particularly Steve Kelling, Rick Bonney, Janis Dickinson and Jennifer Shirk for inviting me to this workshop.

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The thousands of volunteers on whose observations this work is based.

Photographer Alice Baillie