# Wader studies for the 21st century – supporting international conservation

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The effective conservation of waders depends not only on a knowledge of population size and trends, but also on measuring the demographic parameters – recruitment and survival rates, as well as immigration and emigration – that govern them. We urgently require the systematic determination of demographic rates on an international, flyway scale, making full use of and extending existing studies carried out by a combination of counters, ringers and wader ecologists. The International Wader Study Group is uniquely placed to play a central role in co-ordinating the activities of volunteer and professionals in this field.

## INTRODUCTION

A skim through the last 20 years of the *Wader Study Group Bulletin* reveals the vast leaps and bounds in our understanding of these marvellous creatures that have occurred in that short period. Yet huge challenges remain. The pace of change on our shrinking planet grows ever faster, threats to wetlands continue to increase, and we must continue to expand our understanding if we are to safeguard wader populations for future generations. *Bulletin 100* seems a good point at which to take stock of current knowledge and assess the effectiveness of available information to support the international conservation of wader populations, and reflect on how to improve that situation.

It is not merely our knowledge that has undergone substantial change: over the last 20 years, most European countries have become bound by international nature conservation legislation (e.g. the European Union Directive on the Conservation of Wild Birds) and conventions (e.g. the Ramsar and Bonn Conventions) to co-ordinate measures to conserve migratory waterbirds. The long-distance migratory nature of waders and their reliance upon networks of discrete wetland units make them a particular focus for concerted international action – they cannot "belong" in any sense to one state on the surface of the globe. Despite continued wetland loss and degradation, we have a great deal for which to be thankful – without international and domestic legislation, things would be very much worse! More to the point, we now have mechanisms that can convert scientific information into conservation action.

Plenty of reason then, to be cheerful! Yet still, I get a guilty feeling that we have begun to "sleep on the job". Despite better knowledge and improved legal frameworks to enable site-based conservation, it seems to me that we are starting to slip behind the race to protect wader populations for the future. In particular, despite promising progress, 40 years of intensive ringing and count activity seem to remain under-exploited and little used to their full potential. So, the question is: how can we do better?

The most important nature conservation need is to be in a position to monitor the long-term health of all wader populations. What information do we need about a wader population to monitor its long-term well-being? The hierarchy of information required for this purpose falls into two convenient bundles:

(i) The geographical definition of a population, in terms of all those sites used by a population throughout the course of its annual cycle,
(ii) Having defined (i), the estimation of population size and an assessment of trends in numbers and distribution to assess its long-term conservation status.

## BIOGEOGRAPHIC POPULATION DEFINITION

Pioneer ringing studies formed the basis for the remarkable synthesis presented by Davidson & Pienkowski (1987), the first attempt to provide baseline macro-information on wintering, migration staging, moulting and breeding areas and the links between them. Such knowledge is essential to define the sites and migration corridors exploited by discrete populations of birds and hence to promote cohesive and supra-national conservation strategies to maintain and improve conditions for these populations throughout their entire migratory systems (Davidson *et al.* 1998). We await with enormous anticipation the major upgrading of this knowledge in publication of the *Atlas of Wader Populations in Africa and Western Eurasia* presently in consultation, to sit alongside similar syntheses for the Anatidae and Geese by Scott & Rose (1996) and Madsen *et al.* (1999). This keystone publication will define the known structure of wader populations throughout the Africa and West Eurasian region, but will also flag up holes in our knowledge. With the great upsurge in new telemetric, genetic and stable isotope techniques, it will become increasingly possible to tackle these holes, to define geographically or biologically separated wader population units and identify members of such groups, often in ways unimagined before the advent and application of such techniques. Given such knowledge, the challenge remains to establish linkages between sites, to contribute to the development of cohesive site safeguard networks (such as the European Union *Natura 2000 Network* of designated sites, both as Special Protection Areas under the Birds Directive and Special Areas of Conservation under the Habitats

Directive). Protection of a network of the most important breeding, staging, moulting and wintering sites sets the minimum standard for the information requirement relating to each population.

## POPULATION TRENDS

Having defined a set of discrete populations, the next challenge is to adequately track changes in their abundance over time, the long-term objective of Wetlands International's International Waterbird Census (IWC). For species where populations are sympatric on the wintering grounds, there remains a need to establish the population size (and potentially monitor trends) at other times of the annual cycle, such as at the breeding grounds (Piersma 1986). Even for populations that are allopatric on the wintering grounds, at the supra-national level, there has been a history of difficulties in integrating wader count databases. Species with discrete wintering areas and little between-site interchange at key stages of the life cycle may enable near-complete counts upon which to generate trends. However, for common and widespread species, sample counts at selected wintering sites carried out in mid-winter may represent the best means for indexing population change using statistical techniques to assess significant changes over time (e.g. Underhill & Prys-Jones 1994, Prys-Jones *et al.* 1994). The WSG wader count database is currently managed from Wetlands International in Wageningen under the stewardship of Lieuwe Haanstra. After re-checking and validating the entire database, analysis of population trends will soon be underway to bring waders in line with routine reporting on the Anatidae (e.g. Delany *et al.* 1999). Having completed this important task, it is vital that some appraisal of the existing data is carried out to assess the value of using mid-winter counts to determine abundance in the various Western Palearctic wader populations. It could well be that counts at other stages of the life cycle present a better basis for determining population size, either by sample index or attempted complete coverage, but this assessment needs to be undertaken to ensure maximum efficacy in the future monitoring of all wader populations. Despite huge increases in our understanding of such relationships through ringing and co-ordinated counts, for many populations, we remain far from achieving this goal, a clear priority for the future.

Although monitoring total numbers at the population level is desperately important, the actual numbers themselves are inevitably subject to count (and other) errors and omissions in their compilation. Although they can be used to generate trend information, we are often ignorant of the magnitude and source of errors and bias. Fundamentally, the changes in numbers themselves cannot provide information about the nature and causes of the population changes that may be identified. Although the wader atlas and the routine reporting of annual trend indices for the best-covered wader populations should bring the process to the present, how can we interpret the changes that we observe? What critical additional information do we need to obtain to support effective future conservation of wader populations? It is clear we need to be able to understand the factors affecting changes in numbers, and to do that requires further monitoring if we are to effectively target conservation action. Two areas appear most in need of attention:

1. We need to monitor demographic parameters to be able to interpret changes in numbers – it is no good tracking a declining population if we cannot determine the causes of declines (i.e. to determine whether these result from reductions in breeding success and/or decreases in survival and hence determine "why?"). This has been done with spectacular success by Boyd & Piersma (2001), who were able to show that changes in abundance in Red Knots *Calidris canutus islandica* wintering in Britain from 1969 to 1995 could be explained by differences between recruitment and mortality. Numbers fluctuated as a result of factors affecting survival as well as reproduction and they also demonstrated that density-dependent processes affected reproduction. This type of approach is especially important for hunted quarry species – breeding habitat creation may not compensate for unsustainably high kill rates, so it is important to understand the relative contributions of these factors and be able to monitor these over extended periods to detect change statistically.
2. We need to distinguish shifts in distribution from changes in overall numbers. A static observer at a specific staging site may witness declining numbers of birds because of more rapid turnover (i.e. reduced stopover times, perhaps the result of declining habitat quality), without any change to the total volume of individuals using a site. Similarly, with recent climate change, an observer at a distant traditional wintering site may witness dramatic declines caused not by overall population decline or changes in local habitat, but simply short-stopping of birds higher up the flyway. Why go further, if climate change enables you to remain nearer to your breeding grounds?

I will now deal with these aspects in more depth.

## DEMOGRAPHIC MONITORING

When we can define populations and describe changes in abundance over adequate periods of time, we must be able to differentiate small-scale fluctuations from serious long-term declines (particularly those attributable to human activity). The former probably reflect natural background "noise", the latter necessitate conservation intervention and action. The ability to differentiate between these elements is vital, and relies on a fundamental understanding of short and long-term demographics. Such an understanding requires a broad knowledge of the vital processes that determine abundance, namely the annual reproduction and mortality rates. Simultaneous measures of these parameters need to be compiled over a long-enough timescale to account for the annual fluctuations that are typified especially by high arctic breeding waders that may often suffer poor breeding output because of natural changes in weather and predation pressure. Equally, temperate wintering waders may suffer high mortality in unusually severe winters. We therefore need to establish annual measures of reproductive success and adult survival, and know about those critical stages in the life cycle that affect them, if we are going to be in a position to understand the causes behind population trajectories.

Field-sampling of age ratios to determine the annual proportions of first-winter geese is long established and used to model changes in population size of certain waterbirds (e.g. Boyd & Ogilvie 1969). It is therefore a little surprising that this is not the case for some of the commoner waders. Several can be aged (with patience, practice and care) from characteristics visible in the field (e.g. Eurasian Oystercatcher *Haematopus ostralegus*, many plovers and *Calidris* sandpipers), though distinct juvenile plumage is often lost so early that age-determination in winter is no longer possible (Minton, this volume). On the other hand, they can certainly be aged in the hand. Indeed, Gromadzka (1998) found a good relationship between annual numbers of juvenile Dunlin *Caldris alpina* caught in the Vistula Mouth (Poland) and hatching success of Dunlin in the eastern Yamal Peninsula in Russia (where this population breeds (Gromadzka & Ryabitsev 1998)). She found that the years when few juveniles were caught corresponded to those when breeding conditions on the tundra were poor for waders, and when autumn numbers of Curlew Sandpiper *Calidris ferruginea* and Little Stint *Calidris minuta* were also low in the Baltic. This example suggests that age-ratios in samples of waders caught for ringing may well provide a basis for generating an index of recruitment rates for several species, despite potential bias. In Britain, there is an archive of over 1 million ringed waders, most caught in the last 40 years. Yet there has been little systematic effort to exploit these data to assess their potential to offer insight into long-term changes in population size. Juvenile/adult ratios amongst Oystercatchers and Knots wintering on the Wash have been used successfully in population modelling, and show that recruitment rather than survival tends to drive changes in abundance (Atkinson *et al.* 2001). This is an important finding in itself, but more investigation is needed to verify the applicability of this method to other species and to other sites. Clark *et al.* (2002) attempted an exploratory investigation at the behest of the Joint Nature Conservation Committee, and recommended that a weighted index approach be used to generate confidence intervals and avoid the over-representation of small catch ratios in the index. Their findings seem most encouraging, with large-scale between-year fluctuations in breeding success in all high arctic species such as Sanderling *Calidris alba*, Knot and Turnstone *Arenaria interpres*, much as one would expect. Much more effort needs to be invested to validate even the simple assumptions made in these approaches and to improve our techniques. Clark *et al.* (2002) offer a suite of recommendations for further analysis and to develop more robust techniques. Nevertheless, the need to obtain even a crude annual assessment of breeding success is an urgent one and (at least, it seems to me) worth immediate investment for future gain.

We can do better still. The process should not stop there – measuring levels of fledgling production on the breeding grounds or even return rates to the wintering grounds is only part of the story if we are to assess reproductive success in a meaningful manner. We still need to measure recruitment of young birds into the breeding population and the annual proportions of breeding-age adults that breed successfully. These measures are key parameters if we are to understand the factors affecting population size, but they require careful study and well planned colouring marking programmes.

Similar considerations apply to the estimation of annual survival. Techniques for doing this from recaptures and even sparse recovery data are becoming ever more sophisticated (e.g. the MARK set of capture-mark-recapture methods, White & Burnham 1999). Despite this, many contemporary estimates of annual survival for a broad spectrum of waders date back to the pioneering work of Boyd (1962) based only on recovery data! The effective use of some of capture-mark-recapture techniques was ably demonstrated for Moray Firth Redshank *Tringa totanus* by Insley *et al.* (1997), who documented age-specific differences in annual survival and attempted to explain between-year differences in survival in terms of the severity of local weather. The use of mixed models that incorporate recovery data and resighting/recapture data would be especially valuable in combining assessment of site-fidelity, recapture-probability and survival-rate estimations. The analysis of Insley *et al.* (1997) was incredibly important, not least because it flagged up the need for discipline in study design. They concluded: "*Organised annual ringing programmes* [my italics] of wintering waders on British estuaries have the potential to monitor long-term changes in survival rates and productivity". This was taken up in the British Trust for Ornithology Ringing Strategy (Baillie *et al.* 1999), but needs implementation at international level to realise its true potential.

There is also great value in monitoring vital rates through direct breeding studies. Annual adult breeding female survival is one of the most important of all population parameters. Therefore colour-marking and resighting of breeding adults on the nesting grounds, in concert with monitoring of local breeding success, remains one of our best tools for monitoring populations. To do this most effectively requires differentiation between survival rates on a seasonal basis, i.e. partitioning survival between different periods in the annual cycle, as demonstrated for Pink-footed Geese *Anser brachyrhynchus* by Madsen *et al.* (2002). The most important division is between survival rates for the breeding and non-breeding periods, and it is preferable that the non-breeding period be further divided between the migration and over-wintering periods. This may well be possible for well-watched colour-marked species with networks of observers along the relevant flyways. Madsen *et al.* (2002) were able to demonstrate that, during 1990–1999, declines in survival occurred amongst their marked geese over the summer period, in contrast to stable survival trends in autumn and winter. They were therefore able to argue that changes in the annual winter hunt (for example) were not the cause of overall declines in annual survival. Critically high mortality rates during the breeding season, for example, may flag up simple recuperative action at the relevant time of year. Such an approach helps to identify when critical mortality events occur in the annual cycle. In turn, the specific geographical areas where this takes place can be established and appropriate, targeted conservation action taken. Again, our immediate challenge is to design best practice – the experts need to agree on appropriate and feasible study design to provide optimal data and ensure efforts invested now are not wasted in respect of future potential analyses. Perhaps it would be appropriate for the Wader Study Group to hold one or more workshops to co-ordinate actions on the use of ringing and census information to generate data on survival and productivity, to agree core aims and recommend best practice for the future.

## CHANGES AT THE SITE OR REGIONAL LEVEL

Finally, short-stopping is becoming increasingly common: climate change has brought warmer temperatures to higher latitudes in recent winters, such that the many migratory birds remain further north and east along their flyways in Europe than was formerly the case. Count data and ringing recoveries from Lithuania, Poland and Belarus have consistently shown eastwards shifts in the wintering centre-of-gravity of waterbird distributions and ringing recoveries amongst species such as the Mute Swan *Cygnus olor*, Mallard *Anas platyrhynchos* and Coot *Fulica atra* (Svazas *et al.* 2001). These changes undoubtedly have contributed to changes in abundance witnessed further west (including waders, Austin *et al.* 2000), so it is increasingly important that wader count networks adequately cover all potentially relevant sites in order to detect such change. It is also important that ringing activities continue, in order to contribute to our understanding of changes in staging and wintering distributions of birds that formerly wintered in different areas to those in which they do now or may in future.

## SOME TENTATIVE CONCLUSIONS

The most critical objectives should be to maintain and increase count coverage networks and ringing effort, enhance collaboration and co-ordination and improve feedback to counters and ringers, especially in terms of what to do and when to do it. Despite great developments in analytical tools, many of the approaches require carefully designed data collection protocols to make the best of the limited data and meet theoretical assumptions. It is vital that efforts are co-ordinated at an international level, and that recommended best practices are agreed and developed to ensure the best quality data collation on measures of annual survival and breeding success for specific populations. Finally, some case studies to tackle these issues at a population level would be highly desirable in order to identify the pitfalls and challenges of such an approach – the obvious priority species are those that are hunted and also of unfavourable conservation status on Annex II of the EU Birds Directive. These would include Jack Snipe *Lymnocryptes minima*, Redshank and Black-tailed Godwit *Limosa limosa*, but particularly well-studied populations, such as *schinzii* or Norway-breeding Dunlin or Icelandic Black-tailed Godwits would also be model candidates. Perhaps there is a role here for informal groups to be established within the Wader Study Group to compile knowledge on particular populations, recommend future actions and act as contact points. Finally, the WSG is unique in the interplay between its professional and non-professional membership. At a time when there have never been more professionals involved in studying waders, few are encouraged in their work to take a lead at the international level. There is a need to build on the historic partnerships between the enthusiasm and commitment of the non-professionals with the expertise and theory of the professionals to encourage best practice in all levels of monitoring activity. We miss this opportunity at our peril.

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## REFERENCES

**Atkinson, P.W., Clark, N.A., Clark, J.A., Bell, M.C., Dare, P.J. & Ireland, P.L.** 2001. *The effects of changes in shellfish stocks and winter weather on shorebird populations: results of a 30 year study on the Wash.* BTO Research report 238. British Trust for Ornithology, Thetford.

**Austin, G.E., Peachel, I. & Rehfisch, M.M.** 2000. Regional trends in coastal wintering waders in Britain. *Bird Study* 47: 352–371.

**Baillie, S.R., Furness, R.W., Clark, J.A., Green, R.E., Gosler, A.G., Ormerod, S.J., Peach, W.J., Stroud, D.A., Sutherland, W.J. & Wilson, J.D.** 1999. The Scientific Strategy of the BTO Ringing Scheme. *Ringing & Migration* 19 (supplement): S129–143.

**Boyd, H.** 1962. Mortality and fertility of European Charadrii. *Ibis* 104: 368–387.

**Boyd, H. & Ogilvie, M.A.** 1969. Changes in the British-wintering population of the Pink-footed Goose from 1950 to 1969. *Wildfowl* 20: 33–46.

**Boyd, H. & Piersma, T.** 2001 Changing balance between survival and recruitment explains population trends in Red Knots *Calidris canutus islandica* wintering in Britain, 1969–1995. *Ardea* 89: 301–317.

**Clark, J.A., Clark, N.A., Atkinson, P.W. & Robinson, R.A.** 2002. An investigation of adult/juvenile age ratios of waders in cannon-net and mist-net catches in Britain and Ireland and their use in measuring breeding productivity. Advisory report to JNCC, British Trust for Ornithology, Theford.

**Davidson, N., Stroud, D.A., Rothwell, P.I. & Pienkowski, M.W.** 1998. Towards a flyway conservation strategy for waders. *International Wader Studies* 10: 24–38.

**Davidson, N. & Pienkowski, M.W.** 1987. The conservation of international flyway populations of waders. *Wader Study Group Bull.* 49, supplement: 1–151.

**Delany, S., Reyes, C., Hubert, E., Pihl, S., Rees, E., Haanstra, L. & van Strien, A.** 1999. *Results from the International Waterbird Census in the Western Palearctic and Southwest Asia 1995 and 1996.* Wetlands International Publication 54, Wageningen.

**Gromadzka, J.** 1998. Numbers of juvenile Dunlins *Calidris alpina* ringed in the Vistula Mouth (southern Baltic, Poland) in relation to arctic breeding conditions. *International Wader Studies* 10: 85–87.

**Gromadzka, J. & Ryabitsev, V.K.** 1998. Siberian Dunlins *Calidris alpina* migrate to Europe: first evidence from ringing. *International Wader Studies* 10: 88–90.

**Insley, H., Peach, W., Swann, B. & Etheridge, B.** 1997. Survival rates of Redshank *Tringa totanus* wintering on the Moray Firth. *Bird Study* 44: 277–289.

**Madsen, J., Cracknell, G. & Fox, A.D. (eds.)** 1999. *Goose Populations of the Western Palearctic. A review of status and distribution.* Wetlands International Publ. 48, Wetlands International, Wageningen, The Netherlands. National Environmental Research Institute, Rønde, Denmark. 344 pp.

**Madsen, J., Frederiksen, M. & Ganter, B.** 2002. Trends in annual and seasonal survival of Pink-footed Geese *Anser brachyrhynchus*. *Ibis* 144: 218–226.

**Piersma, T.** 1986. Breeding waders in Europe. A review of population size estimates and a bibliography of information sources. *Wader Study Group Bull.* 48, Supplement: 1–115.

**Prys-Jones, R., Underhill, L.G. & Waters, R.J.** 1994. Index numbers for waterbird populations. II. Coastal wintering waders in the United Kingdom, 1970/71–1990/91. *J. Appl. Ecol.* 31: 481–492.

**Scott, D.A. & Rose, P.M.** 1996. *Atlas of Anatidae Populations in Africa and Western Eurasia.* Wetlands International Publication No.41, Wageningen, The Netherlands. 336 pp.

**Svazas, S., Meissner, W., Serebryakov, V., Kozulin, A. & Grishanov, G.** 2001. Changes of wintering sites of waterfowl in Central and Eastern Europe. OMPO Special Publication, Vilnius.

**Underhill, L.G. & Prys-Jones, R.** 1994. Index numbers for waterbird populations. I. Review and methodology. *J. Appl. Ecol.* 31: 463–480.

**White, G.C. & Burnham, K.P.** 1999. Program MARK: survival estimation from populations of marked animals. *Bird Study* 46 (supplement): S120–139.