Fifty years of scientific research by The Wildfowl & Wetlands Trust

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Effective conservation of any species depends on the sound understanding that can only come from research and monitoring. The 50th Anniversary seems an opportune time to look back over WWT's research, examine its development and the contribution it has made to the conservation of waterfowl, and also to set the main findings of this research within their wider scientific context. Together with education and conservation, research has always been one of WWT's main activities. The past 50 years have seen an enormous growth in ornithological research, both in Britain and elsewhere, as well as the growth of a thriving conservation movement and the establishment of a network of nature reserves. It is against this background that WWT's research development must be viewed.

In 1957, ten years after its establishment, WWT had a research staff of six. The research director was Dr G.V.T. Matthews, and the staff included such now well-known names as Hugh Boyd, George Atkinson-Willes and Janet Kear. It has held a scientific advisory committee since 1954, chaired until 1966 by Sir Landsborough Thomson. At that time, the research committee included some very well known scientists, and in 1960, had no less than five Fellows of the Royal Society, including Sir Julian Huxley. In common with many other research units, the staff increased in numbers in the subsequent years, reaching over 30 in the 1990s, including some on short-term contracts. However, in recent years WWT has not escaped the political and economic forces that have influenced all research bodies in Britain. Increasing financial constraints and government pressure have forced the research to become less broadly based and more focused on those problems of most immediate urgency and application.

In the early years, research covered a surprisingly broad range: anything that added to knowledge was considered worth doing, and behaviourial studies were particularly popular. In more recent years, research has become increasingly concentrated on population ecology - on those aspects of science that more closely underpin conservation. In my view, it is right that this is so, as improved knowledge has increasingly brought the plight of the world's biota to our attention. Much of WWT's work in ecology and monitoring of populations has for many years been funded by the statutory conservation agency, the Nature Conservancy and its successor bodies. This did much to focus the research on population issues. Nonetheless, not being entirely dependent on government funding, WWT retained, throughout, some measure of freedom which has enabled it to maintain a broad research base, and to keep going the all-important long-term population studies which have added so much to scientific understanding (and incidentally to the scientific reputation of WWT).

When the (then) Severn Wildfowl Trust was established in 1946, practically nothing was known about the populations

of wildfowl found in Britain, about their numbers and distributions, or about their migration patterns. It was widely perceived that populations were declining, and that the main cause was over-shooting by wildfowlers. It is testimony to the success of WWT that the information that accrued from early research is now regarded as common knowledge.

In the sections below, various aspects of WWT 's research are discussed, and some attempt is made, with the benefit of hindsight, to assess their wider relevance.

Behaviour

The assemblage of a large collection of captive waterfowl at Slimbridge, which, within a few years contained a large proportion of the world's waterfowl species, provided a unique opportunity for comparative study. The science of ethology was just emerging, and early visitors who made use of the collection for behaviourial studies included Lorenz and Johnsgaard, both of whom published prolifically from their studies at Slimbridge. Some of the pioneering work on comparative behaviour was done at Slimbridge, notably on the use of courtship displays in taxonomy. Another visitor to Slimbridge in those early years was Niko Tinbergen, a supervisor of Frank MacInney, whose analysis of duck behaviour became the first PhD study based at the Wildfowl Trust.

In 1955, Dr G.V.T. Matthews took up the position of Assistant Director (Research). He took advantage of the large number of 'surplus' Mallard at Slimbridge and other centres to continue his studies of bird navigation. In line with earlier work by Bellrose (1958), he showed that Mallard *Anas platyrhynchos* that were caught, transferred and released, almost always headed northwest, regardless of the position of the release site with respect to the capture site (Matthews 1961). Moreover, this northwest direction did not reverse with the seasons, as one might have expected in migrants. These findings were so inexplicable that he called the phenomenon 'nonsense orientation', and to this day it remains an enigma. He showed that fixed orientation was adhered to only for 1-2 km from the release site and, somewhat surprisingly, that it over-rode any influence of familiar landmarks. The important development, however, was that he was able to use this behaviour to study the time-keeping mechanisms necessary in any migrants which use sun or stars as navigation cues. By keeping Mallard on artificial days, and clock-shifting them, he could change the preferred flight direction in a manner appropriate to the time-shift involved. This work aroused international interest at the time, helping to put WWT's research on the scientific map, and perhaps more importantly, it introduced an experimental approach to the work of WWT. It coincided with a period of growing interest in migration, both at WWT and elsewhere.

Population ecology

The first organised attempts at widescale counts of waterfowl in Britain were started in 1947 under the auspices of the International Wildfowl Enquiry Committee (the precursor organisation to the International Wildfowl Research Bureau, now Wetlands International). The aim was to get as many sites counted as possible each month from September to March, year after year. WWT took over responsibility for the counts from 1954 when the organiser, George Atkinson-Willes, moved to Slimbridge. By this time, the numbers of waters counted regularly had risen to around 500, and more than 700 volunteer counters were involved.

Although attempts had been made to count other bird species by use of amateur observers, notably in the annual Heron *Ardea cinerea* census (from 1928), National Wildfowl Counts were the first attempts to undertake countrywide counts of a whole group of birds on a regular basis, providing indices of both geographical distribution and population sizes, including month-to-month and year-to-year changes. The information from these counts, by identifying key sites,

provided the basis for establishing a network of refuges around the country, designed to reverse population declines and to conserve populations long-term. Not all species could be readily counted in this way, with the amateur manpower available at the time, and aerial surveys were used to give a more complete picture (one staff member, J.K.E. Eltringham, was employed specifically for the purpose). Only in the 1960s did it become possible to count mainland populations from the ground only, though aerial survey was still needed for some offshore islands. In the mid 1960s, an International Wildfowl Count scheme was set up by IWRB, based at Slimbridge, aiming to cover the whole of the western Palaearctic in January each year, and in some years also in November and March. Meanwhile, the numbers of waters counted regularly in Britain had risen to around 1,200, with some 800 counters involved.

Apart from the Heron census, similar national annual surveys of bird numbers were not attempted by the British Trust for Ornithology until 1962, with the start of the Common Bird Census, followed by the Birds of Estuaries Enquiry from 1969. This latter survey resulted in better coverage of coastal waterfowl, in addition to providing the first assessments of coastal wader numbers. In 1993 the information from the two major surveys of wetland birds were amalgamated into a single Wetland Bird Survey (WeBS).

Although the organisation of the counts has changed over the years, the important points are that coverage of sites has increased progressively, and that sufficient sites are counted in successive years to provide an index of the countrywide population changes occurring in a wide range of species. The first 15 years of count results were published in a monograph edited by Atkinson-Willes (1963) which provided a definitive outline of knowledge of wildfowl numbers and distribution at the time. It was brought up to date about 20 years later with a second edition (Owen *et al.* 1986), while more recent counts were summarised in a paper by Kirby *et al.* (1995).

The 1950s saw some important breakthroughs in study techniques which made other things possible. One was the discovery by Hugh Boyd that young geese could be distinguished from adults in the field, enabling annual assessments of breeding success, as well as of numbers. He also discovered that White-fronted Geese *Anser albifrons* could be distinguished individually by the black 'medals' on the breast, facilitating field studies of individual behaviour (Boyd 1954). A second important breakthrough came with the development by Peter Scott of the rocket-propelled net, which enabled the capture of large numbers of geese and other birds for ringing. A third was the development of large Darvic (plastic) rings, which, with their conspicuous numbers, enabled the repeated field identification of individual geese and swans, without the need to retrap them. Many of the studies which have continued to the present, and done so much to establish WWT's scientific reputation, were dependent on these early developments in field techniques.

Until the 1940s, very few wildfowl had been ringed, and the development of special ringing centres, notably at Abberton, Nacton, Peakirk and Slimbridge, suddenly enabled several thousand ducks to be trapped and ringed each year. Some of the sites were old 'duck-decoys', previously used to catch ducks for human consumption, but others used newly-developed trapping techniques. WWT also helped amateurs to set up ringing stations elsewhere, and encouraged similar operations in Europe. Within a few years, the resulting recoveries, extending from eastern Canada to eastern Siberia, and from the northern tundra to the Afrotropics, gave an almost unbelievable picture of widescale waterfowl migration. They served to emphasise the crucial importance of international collaboration in conservation and of the need to establish international networks of reserves if waterfowl populations were to be conserved long-term.

Another interesting finding to emerge in the 1950s concerned the breeding areas of

the various goose populations that wintered in western Europe. Expeditions which left Slimbridge in the 1950s, to discover the breeding areas of Pinkfeet *Anser brachyrhynchus* in Iceland, were the first of many to northern breeding sites. It emerged, contrary to the situation in ducks, that goose populations from particular breeding areas maintained their discreteness year-round by migrating to particular wintering areas. The Pinkfeet from Iceland-Greenland wintered in Britain, while those from Svalbard wintered in Denmark-Holland. Similarly, the Barnacles from Greenland wintered in Ireland and the Hebrides, those from Svalbard wintered on the Solway, while those from Siberia wintered in Holland. Their populations were therefore effectively closed, and could be studied and managed as single units. The lack of complications of immigration-emigration was a great bonus in population studies.

As the years went by, the advantages of regular annual monitoring became increasingly apparent. First, it showed that the numbers of most wildfowl species in Britain were increasing, providing testimony to the effectiveness of the refuge system as a conservation strategy for wintering populations, and further evidence that over-shooting had previously limited numbers. Moreover, as counting schemes were progressively established abroad, it became apparent that this was not merely a British phenomenon, and that the entire western Palaearctic populations were on the increase. The main exceptions were species, such as Lesser Whitefront *Anser erythropus*, which migrated eastward, and remained subject to high hunting pressure in eastern Europe or the Soviet Union. Interestingly, the western Palaearctic waterfowl populations are now the only northern ones which are increasing, as those in the eastern Palaearctic and even North America (ducks only) are in decline. Destruction of breeding habitat and continuing overhunting are the purported causes. Wildfowlers, who have often proved hostile to the setting up of non-shooting reserves, will probably never know how important these reserves have been to the continuation of their sport at its present level.

The counts have also revealed other aspects of waterfowl biology. First, year-to-year fluctuations in the numbers of many duck species present in Britain in winter are due less to events in Britain than to events in Europe, where local conditions determine when and what proportions of birds move on down the flyway. There is nothing like hard weather in Europe to produce an increase in duck numbers in Britain. Evidently, in their movements throughout the winter, waterfowl are responsive to prevailing conditions. Within the past 30 years, we have seen how Pinkfeet first withdrew from southern Britain, remaining in Scotland as feeding conditions improved there, and then moved south again as feeding conditions deteriorated with the change from spring to autumn ploughing of cereal stubbles.

For geese whose entire populations winter in Britain, and in which young can be distinguished in the field from adults, annual counts have shown how year-to-year changes in numbers depend on breeding success. The biggest increases have followed years of good breeding. One remarkable recent discovery, based on long-term count data, is that most years of poor breeding in Brent Geese *Branta bernicla* coincide with 'lows' in lemming numbers on the Taimyr Peninsula of Siberia, where the geese breed (Summers & Underhill 1987). In these years, foxes and other predators turn to eggs of geese and other birds, lowering their breeding success. Apart from year-to-year fluctuations, the long-term count data have shown a long-term decline in the proportion of young in winter flocks as the populations of Icelandic Greylag *Anser anser* and Svalbard Barnacles *Branta leucopsis* have grown. This has been interpreted as a density dependent response to increased competition on arctic breeding areas which, if the birds don't colonise new breeding areas, could in time stabilise their populations. Other populations have not yet risen to the level at which breeding is affected. As ringing has confirmed, the long-term increase in

goose populations has come mainly from improved survival resulting from lowered hunting pressure.

The effort in counting wintering waterfowl has not been matched by similar effort on the much smaller breeding populations, as breeding surveys were not begun until the mid-1960s. They have been somewhat irregular throughout, the periodic national count of Mute Swans *Cygnus olor* being the most complete. On the other hand, detailed studies were made on the waterfowl breeding at particular sites, notably at Loch Leven, which in the 1960s-1970s had more than a thousand pairs of ducks nesting on a single 40 ha island (Newton & Campbell 1975). This study revealed that large nesting concentrations do not necessarily show high production of young.

By far the highest scientific contribution over the years has come from WWT's long-term studies of Barnacle Geese and Bewick's Swans *Cygnus bewickii*, both involving longitudinal studies of marked individuals (Scott 1988, Owen & Black 1989). These researches stand among the two dozen bird population studies worldwide from which most of our understanding of individual life histories has come. Such studies have revealed fascinating information on age of first breeding, age-related changes in reproduction and survival, lifetime breeding success, relationship between winter condition and breeding success, effects of divorce on lifetime success and many other aspects. Some of these topics have been examined in other species, but special interest attaches to these large waterfowl because of their long-term monogamy and family structure. Both studies were conducted mainly at WWT Centres, and that on Bewick's Swans started with an observation by Peter Scott that the black-and-yellow bill pattern not only differed between individuals (which was known already) but was also consistent from year to year. This provided the means of recognising individuals until a method of catching them was developed in the 1970s, enabling large scale darvic ringing, and the continuation of work on family histories. The history of the Bewick's Swans at Slimbridge has also shown how these birds will respond to a safe refuge and regular feeding. Birds first appeared in the 1950s, with 20 different individuals in 1964, increasing to more than 400 in 1980. The newer research on Whooper Swans *Cygnus cygnus* has also given promising results, and all three studies have given rise to expeditions to examine the birds on their breeding areas.

As a result of one expedition to study Barnacle Geese, brood sizes could be counted just before migration and again just after arrival in their Solway wintering site. This revealed that up to 30% of youngsters could be lost during their first major journey, which was the first reliable estimate of the survival 'costs' of migration in any bird (Owen & Black 1991). It remains to be seen how typical is this initial estimate obtained for a single population in a single autumn.

Pathology

The appointment of a pathologist (J.V. Beer) was one of the first priorities in the newly established WWT. The aims were to provide a post-mortem service for birds which died, and as far as possible to curtail the development and spread of disease through the collection. Over the years, much information was assembled on the frequency of different parasites and pathogens as mortality agents in captive waterfowl. Aspergillosis and salmonellosis were soon brought under control, but tuberculosis has remained a problem, and is the subject of continued research aimed at finding a reliable diagnostic test and vaccine.

Studies of lead poisoning in the 1960s led to the interesting discovery that a large proportion of the Bewick's Swans examined by X-ray were carrying lead gunshot in their tissues, despite their supposed legal protection along the whole length of their migration route. Shooting has continued, and even in 1995 one third of adults examined contained shot. Overall, however, the pathology at

Slimbridge has led to fewer insights and scientific advances than other aspects of WWT's research. This may be because less staff-time has been devoted to it, in turn because disease has not yet emerged as a major factor killing wild waterfowl in Britain (in contrast to North America).

Food, feeding behaviour and habitat management

Studies of the diets of ducks from examination of gut contents led, in the late 1950s, to the first large-scale collaboration between WWT and wildfowlers who supplied the bodies. The resulting information was published in a series of papers by Peter Olney (e.g. Olney 1963, 1968). It was followed by studies on the grazing behaviour of geese and Wigeon *Anas penelope* by Myrfyn Owen, and other studies on the biology and seed production of various food plants by D.F.W. Pollard. Knowledge from all this work was soon put to use in the practical management of reserves, in an attempt to increase their carrying capacity.

Increasing goose numbers soon led to complaints of agricultural damage, a problem addressed in the 1960s by the newly-appointed Janet Kear, who investigated the effects of goose grazing on the yield of grass and cereal grains, and explored various means of reducing damage (Kear 1963, 1970). This work proved important in the political arena because it contested the most exaggerated claims of farmers and enabled WWT to speak with authority on an issue on which the agriculturalists would otherwise have held sway. This is of course a continuing problem, and wild geese have provided a test case of society's willingness to forgo monetary profit for conservation gain. It also illustrated another common aspect of such conflict: in terms of national agricultural production the effects of geese were immeasurably small, but the bulk of the damage was borne by a relatively small number of farmers, especially those near newly-created refuges. The problem has been increasingly tackled by compensation payments and by purchase of crucial areas of farmland, and their management for geese as well as agriculture.

Work on wetland ecology and management gained momentum from the mid 1980s, leading to the production of detailed management plans for all WWT reserves, some of which are sites of international significance. Recognition of the potential for combining wastewater treatment with wetland habitat creation led to field trials of reedbed filters at several WWT Centres. As a result, WWT can now provide authoritative advice on the creation and management of such systems elsewhere. Another achievement was the production of a practical handbook, aimed at helping industry to create, restore or maintain wetlands of value to wildlife on industrial land (Merritt 1994).

Concluding remarks

Looking back, one can perhaps discern three major phases in the research undertaken by WWT. In the first phase, it was the behavioural work that made the biggest scientific impact. This resulted from the unique opportunities provided by the collection, and led to some of the first detailed comparative studies of the behaviour of closely related species, and their use in taxonomy. Some well-known names were involved in this work (notably Lorenz), but because they came as visiting scientists, WWT perhaps received less credit for such work than it deserved.

The second phase, following the appointment of Geoffrey Matthews as research director, saw a flurry of research on migration. There was not only Geoffrey's own work on orientation, but the accumulating ring recoveries were yielding more and more information on the breeding and migration areas of wintering populations. This period saw the development of the rocket-net, large scale ringing of geese, and expeditions to Iceland and elsewhere to discover breeding areas. It was a period of great innovation. It also coincided with the

television natural history series 'Look', chaired by Peter Scott, so the whole nation was kept abreast of what seemed in the 1950s to be amazingly exciting developments. As a schoolboy at the time, the work of WWT became my image of what an elite band of field ornithologists did: they studied wild birds in wild places, with lots of excitement, and the whole effort was eminently worthwhile.

The third phase resulted in a progressive shift to population work. This was partly the result of the maturation of early monitoring and ringing work. There was not much to say in the first few years, but with time the results became increasingly interesting and scientifically useful. It is this type of work which underpins conservation, by which the success of conservation measures can be assessed, and which in the long-term may make the greatest scientific impact (witness the long-term studies of geese and swans). As knowledge of the state of the world's biota has become increasingly available in recent years, it is in my view wholly appropriate that WWT should now concentrate on the ecological survey and monitoring work on which conservation depends. The long-term data sets, for years dismissed as 'mere monitoring', will undoubtedly prove of increasing scientific value in the future, providing unique data bases on the long-term history of populations and their response to change, and on which to answer new questions and examine new ideas.

Another development is likely to be the increasing application of science to the management of wetland reserves. Only in this way can the carrying capacity of reserves be increased so that they can hold more birds throughout the season, and impacts on nearby agricultural land minimised. Much could also be done to improve the breeding success of birds nesting on reserves, through creating habitats that both reduce predation and provide good feeding conditions for newly-hatched chicks.

There are several other aspects of WWT's work that warrant comment. Throughout its history WWT has actively sought collaboration both within Britain and more widely, and has encouraged students and others to work there, making use of the collection and other facilities. This open-door policy has paid off, not just in the science but in providing a wide range of friends and collaborators around the world. It means that there is a further hidden contribution – a large body of research with which WWT's name is not conspicuously associated but which could not otherwise have been done. As part of this effort, WWT has organised several international projects, with collaborative expeditions to Iceland, Greenland, Svalbard and Siberia. WWT also sponsored the studies of the Swedish ornithologist, S.A. Bengston, on the large breeding duck population at Lake Myvatn in Iceland. Secondly, the staff have an extraordinarily good publication record – results of research have appeared in the scientific literature, and periodically in scientific and popular books reviewing the main findings (e.g. Ogilvie 1978, Owen 1980, Scott 1972). It is not surprising, then, that there is hardly a publication on wildfowl in Europe now that does not refer to some aspect of WWT's work.

References

Atkinson-Willes, G. 1963. *Wildfowl in Great Britain*. London: HMSO.

Bellrose, F.C. 1958. The orientation of displaced waterfowl in migration. *Wilson Bull.* 90: 20-48.

Boyd, H. 1954. Notes on the belly markings of White-fronted Geese. *Wildfowl Trust Ann. Rep.* 6: 79-81.

Kear, J. 1963. Wildfowl and agriculture. In: *Wildfowl in Great Britain*, ed. G.L. Atkinson-Willes. London: HMSO. Pp. 315-328

Kear, J. 1970. The experimental assessment of goose damage to agricultural crops. *Biol. Cons.* 2: 206-212.

Kirby, J.S., Salmon, D.G., Atkinson-Willes, G.L. & Cranswick, P.A. 1995. Index numbers for waterfowl populations. III. Long-term trends in the abundance of wintering wildfowl in Great Britain, 1966/67 to 1991/92. *J. Appl. Ecol.* 32: 536-551.

Matthews, G.V.T. 1961. 'Nonsense' orientation in Mallard *Anas platyrhynchos* and its relation to experiments on bird navigation. *Ibis* 103: 211-230.

Merritt, A. 1994. *Wetlands, Industry and Wildlife: a manual of principles and practices.* Slimbridge, Wildfowl & Wetlands Trust.

Newton, I. & Campbell, C.R.G. 1975. Breeding of ducks at Loch Leven, Kinross. *Wildfowl* 26: 83-103.

Ogilvie, M. A. 1978. *Wild Geese.* Berkhamsted: Poyser.

Olney, P.J. 1963. The food and feeding habits of the Tufted Duck *Aythya fuligula. Ibis* 105: 55-62.

Olney, P.J. 1968. The food and feeding habits of Pochard. *Biol. Conser.* 1: 71-76.

Owen, M. 1980. *Wild geese of the World.* London: Batsford.

Owen, M., Atkinson-Willes, G.L. & Salmon, D.G. 1986. *Wildfowl in Great Britain.* 2nd Edition. Cambridge: Cambridge University Press.

Owen, M. & Black, J.M. 1989. Barnacle Goose. In: *Lifetime reproduction in birds*, ed. I. Newton. London: Academic Press. Pp. 349-362

Owen, M. & Black, J.M. 1991. The importance of migration mortality in non-passerine birds. In: *Bird population studies. Relevance to conservation and management.* ed. C.M. Perrins, J.-D. Lebreton & G.J.M. Hirons. Oxford, University Press. Pp. 360-372.

Scott, D.K. 1988. Breeding success in Bewick's Swans. In: *Reproductive Success*, ed. T.H. Clutton-Brock. Chicago: University of Chicago Press. Pp. 220-236

Scott, P. 1972. *The Swans.* London, Michael Joseph.

Summers, R.W. & Underhill, L. 1987. Factors related to breeding production of Brent Geese *Branta b. bernicla* and waders (*Charadrii*). Bird Study 37: 161-171.

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