1. Introduction

The swans, geese and ducks (Anatidae) are characterised by two features which give rise to very special requirements for their conservation:

Firstly, most Anatidae depend on wetlands throughout much of their life-cycle. These habitats are usually rather discrete and separated from each other by vast areas of non-wetland habitat; they are also one of the most threatened habitats in the world, having suffered losses exceeding 50% of original area in many countries during the last century. Wetlands are also highly productive habitats, enabling relatively small areas to support large waterbird concentrations.

Secondly, the Anatidae family includes many migratory populations. The individuals of these populations depend on the utilisation of a network of sites throughout their range in order to complete their annual cycle. This network of sites may extend over thousands of kilometres, and traverse numerous political boundaries and biogeographical zones. Each site in the network plays a critical role, enabling the individuals that use it to move on to the next site in the network. The importance of individual sites is shown by the concentrations of birds which occur there and by the traditional use that many individuals make of individual sites and site networks, year after year.

These features combine to require that any effective conservation programme for the Anatidae must incorporate internationally coordinated measures for site conservation, species monitoring and regulation of any forms of taking. Knowledge of the network of key sites used by each population is thus a basic need for the implementation of policy tools such as the Ramsar Convention and the Bonn Convention's Agreement on the Conservation of African-Eurasian Migratory Waterbirds. This document aims to provide this information for the Africa/Eurasian region.

There have been few attempts to describe the networks of key sites used by the Anatidae in the African/Eurasian region, with the exception of intensive studies of one or two well-known species (e.g. Barnacle Geese in Black, in prep.). Historically, Atkinson-Willes (1976) listed 166 key-sites for European wintering species of Anatidae; this study was revised and updated to 180 sites by Monval & Pirot (1989). These two lists only included wintering sites, so in terms of providing a conservation tool they were very incomplete. The first real attempt to produce a complete key sites network for European Anatidae was by van Roomen & Boere (1989). Their draft report was never published but has been used as a foundation for this publication. A number of other wetland inventories, and the Important Bird Areas (IBA) project of BirdLife International (Grimmett & Jones 1989, Evans 1995), have provided additional information for this study.

The objectives of the present document are therefore to contribute to the conservation of the Anatidae by:

- delineating units of population for each Anatidae species, as a basis for the application of conservation measures;
- providing estimates of the numbers of individuals in each population unit;
- identifying the key sites used by each population;
- indicating the protection status of each site.

In order to achieve these objectives it has been necessary to adopt a number of criteria and definitions which are described in the methods section. The results are then presented in the form of species texts and maps, followed by a large table giving additional data for each key site.

Inevitably, for a major international work of this kind there will be gaps in the information provided. These are due both to existing information not being found or made available, and due to the simple lack of information for certain countries and species. It is hoped and expected that the publication of this document will stimulate further research and the provision of additional data, so that future editions can be even more complete.

Already a great deal of information exists for the Anatidae, not least because of the International Waterfowl Census, which has provided site-based data for many species since 1967. Thus, this document already provides a useful baseline from which to define measures for the recovery of threatened species and populations, for the establishment of protected areas, for the definition of wise use programmes, and for the improvement of monitoring and research programmes.

The compilers hope that this document will act as a stimulus to initiate work to prepare similar atlases for other taxonomic groups of migratory waterbirds and for the Anatidae in other parts of the world.

Finally, this publication could not have been written without major input from a large number of key people who are all listed in the Acknowledgements section. Without their helpful information this report could not have been compiled.

2. Identification of Population Limits

2.1 Summary of 'populations' used in this Atlas

The 'biogeographical populations' which are treated as separate units in this Atlas are listed in Table 1. Several types of 'populations' are recognized:

- the entire population of a monotypic species.
- the entire population of a recognized subspecies.
- a discrete migratory population of a species or subspecies, i.e. a population which rarely if ever mixes with other populations of the same species or subspecies.
- that 'population' of northern hemisphere birds which spends the winter in a relatively discrete portion of Western Eurasia and/or Africa (e.g. northwest Europe, the Black Sea/Mediterranean region, Southwest Asia, West Africa, eastern Africa). In many cases, these 'populations' may mix extensively with other populations on the breeding grounds, or may mix with sedentary populations of the same species during the migration seasons and/or on the wintering grounds. The birds wintering in two or more adjacent regions have often been grouped together into a single larger region, when it seems likely that they belong to the same 'population' (e.g. Black Sea/Mediterranean and West Africa, Southwest Asia and eastern Africa).
- a regional group of sedentary, nomadic or dispersive birds with an apparently rather continuous distribution and no major gaps between breeding units sufficient to prohibit interchange of individuals during their normal nomadic wanderings and/or post-breeding dispersal.

2.2 History of Anatidae population delineation in Western Eurasia and Africa

Pioneering work by Russian ornithologists in the 1960s identified the main 'geographical populations' of Anatidae in the western part of the former USSR and Europe. Isakov (1967) recognized four major flyways for Anatidae in western Eurasia, and provided a preliminary list of 44 wetlands in the former USSR which were of great significance as breeding, moulting, staging and/or wintering grounds. Isakov's four populations were: (1) northern White Sea/North Sea population; (2) European Siberia/Black Sea-Mediterranean population; (3) West Siberian/Caspian/Nile population; and (4) Siberian-Kazakhstan/Pakistan-India population (see Figure 1). Isakov (1970a) attempted to define the breeding grounds of these populations in greater detail, and demonstrated that there was extensive overlap between the various regions.

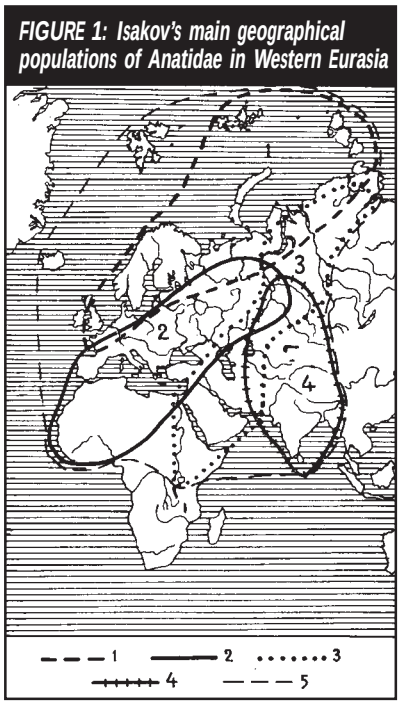

FIGURE 1: Isakov's main geographical populations of Anatidae in Western Eurasia

Shevareva (1970) analyzed 10,600 recoveries of ducks ringed in the former USSR and confirmed the basic geographical populations outlined by Isakov (1967) for *Anas platyrhynchos*, *A. crecca*, *A. acuta*, *A. penelope* and *A. querquedula*.

The concept of 'biogeographical populations' was elaborated in some detail by Atkinson-Willes *et al.* (1982), and the following account is based largely on these authors. In its simplest form, a population comprises a discrete unit with a clearly defined 'flyway' linking the breeding and moulting grounds to the terminal winter quarters. In some cases, the unit will comprise the entire population of a species or subspecies, as in *Branta ruficollis*, *Anser albifrons flavirostris* and *Branta bernicla bernicla*. (Note that in North America, the term 'flyway' is used in a rather different manner to refer to an

administrative unit for the management of waterfowl populations, and is identical for virtually all duck species).

A number of other species and subspecies are known, from ringing and migration studies, to have two or more distinct populations which seldom if ever mix at any stage in their annual cycles, and should therefore be treated separately. The conditions which these various populations experience are likely to be quite different; it is therefore reasonable to suppose that each of them will, in isolation, have evolved its own peculiar adaptations. The Western Palearctic provides several examples of these discrete units, notably the two populations of *Anser brachyrhynchus*, the three populations of *Branta leucopsis* and the isolated west Mediterranean population of *Marmaronetta angustirostris*.

Such a division of species into discrete population units is, however, usually impossible, especially amongst the common and widespread species. For most species of Anatidae which have been the subject of intensive ringing studies, it is clear that no such biogeographically discrete populations exist. Thus in most of the Palearctic ducks, there is no clear-cut relationship between the various breeding and wintering grounds. The flocks wintering in any given area are likely to contain individuals from several of the main breeding grounds, and similarly birds from the same breeding areas may often occur in a number of widely separated winter quarters. In most species, there is a great deal of mixing across huge longitudinal ranges, and clear dividing lines are seldom present. An alternative method of sub-dividing species into convenient units for conservation and management action must therefore be devised. Otherwise the total numbers would be so large that the 1% criterion would cease to be relevant and priorities for conservation and management would be difficult to define.

2.3 Practical versus biogeographic units of population

Atkinson-Willes (1976) and Atkinson-Willes *et al.* (1982) recommended that the 'flyway' concept be abandoned for common and widespread species in the Western Palearctic, and that population 'units' be based on the main wintering regions. On this basis, the individuals wintering in a given region are treated as a single population, regardless of their distribution at other times of the year.

This concept was applied to the Palearctic ducks wintering in Western Eurasia and the northern half of Africa. Within this area, a total of five biogeographical regions were defined: northwest Europe, Black Sea/Mediterranean, Caspian/Gulf, Turkestan/Pakistan, and Tropical West Africa (Atkinson-Willes, 1976). Atkinson-Willes set the line between northwest European and the Black Sea/Mediterranean regions north of the Alps, and included central Europe in the Black Sea/Mediterranean region. He included the Nile Delta (Egypt) and Azraq Oasis (Jordan) in the Black Sea/Mediterranean region, and remained undecided as to the location of the important wetlands of the Seistan Basin on the border between Iran and Afghanistan.

The principles involved in defining these particular wintering regions were as follows:

- a region must be large enough and have a sufficiently wide range of habitat and climate for the birds to remain within its boundaries in all normal winters;
- it should, as far as possible, be bounded by physical barriers sufficient to prevent the easy movement of birds from one region to another, or by zones in which the species under review is either scarce or absent;
- the boundaries of the region should preferably be uniform for all species; the alignment may, however, be varied to take into account specific peculiarities in distribution;
- the boundaries of the wintering regions should include the migration routes leading to them.

In support of the population boundaries chosen by Atkinson-Willes (1976), there is a considerable body of evidence, mostly from ringing studies such as those by Shevareva (1970) and Perdeck & Clason (1980), that most Anatidae in Western Eurasia follow a southwesterly course from their breeding grounds to their winter quarters. For species with a relatively continuous breeding range across northern Eurasia and a relatively continuous wintering range across southern Eurasia (to Africa, India and southeast Asia), there is a very strong tendency for birds in the west to winter in the west, and birds in the east to winter in the east. For many species of Anatidae, ringing recoveries have demonstrated that the majority of birds breeding in northwest Europe (including Scandinavia) winter from western Europe south in varying degrees to the west Mediterranean and northwest Africa. The majority of birds breeding in northeast and central Europe (in the east up to the Urals) generally follow a more easterly route to winter from the Black Sea and southeast Europe through the Mediterranean basin to West Africa and the central Sahel zone. Birds breeding in western Siberia (notably in the basin of the Ob and Irtysh rivers) generally migrate southwest through the Caspian region to the Middle East and, in some cases, also to northeast and eastern Africa.

Atkinson-Willes *et al.* (1982) discussed some of the problems arising from this rather arbitrary approach to the selection of geographical units of population. The main problem arises in cases where a species is abundant in one region, but scarce and at the edge of its range in the next. If the populations in the two regions are treated separately, the 1% criterion will place undue emphasis on sites in the region of minimal importance. The obvious solution is to combine the two regions, or to amend the boundary between them, so that the marginal overspill is included in the main population. However, it is important to distinguish between small relict populations, which are genetically and geographically isolated from all other populations of the species, and those which comprise no more than a minor extension of the normal distribution. The former should be treated separately, the latter as part of the main population.

Another problem arises where the number of individuals wintering in a region is very much smaller than the number passing through on migration. It has been suggested that two 1% levels should be adopted in this situation, one based on the number occurring on passage, for use in autumn and spring, the other on the number remaining in winter. Atkinson-Willes *et al.* (1982) regarded this as an unnecessary complication, and recommended that the small winter remnant be lumped with the main population with which it is associated; the same 1% level should then be used throughout. For example, the small numbers of *Anas querquedula* which remain throughout the winter in the Mediterranean Basin and Middle East should be regarded as part of the main populations wintering in West Africa and eastern Africa, respectively. An exception to this should, however, be made in those instances in which two populations from distinct breeding areas are involved. In this situation, separate criteria might be justifiable. Examples might occur in *Anas acuta* and *A. clypeata* in northwest Europe. The rather small wintering populations in this region consist of birds from Fennoscandia, the Baltic States and northwest Russia, while many of the birds occurring on migration originate from breeding areas further to the east and winter in the Mediterranean basin and West Africa.

Meininger *et al.* (1995) have suggested that when two or more populations use a site during the course of a year, the 1% level used at a particular time of year should be the 1% level of that population which is most abundant at that time of year. When it is unclear which population dominates, the highest level should be applied.

In most cases, there should be no difficulty in separating recognized subspecies as discrete populations of the species considered. The recognized subspecies of Anatidae treated in this report are either (a) totally discrete, e.g. the African and Madagascar subspecies of *Thalassornis leuconotus*, (b) show only a narrow zone of intergradation or secondary contact zone where they come together e.g. the two subspecies of *Anser fabalis* and the two subspecies of *Plectropterus gambensis*; or (c) are separated from other populations during the breeding season by unsuitable terrain e.g. the three subspecies of *Somateria mollissima*.

2.4 Existing reviews of Anatidae populations in the Western Palearctic

Atkinson-Willes (1976) described the main wintering regions for twelve species of Anatidae in the Western Palearctic (*Cygnus columbianus*, *Tadorna ferruginea*, *T. tadorna*, *Anas penelope*, *A. crecca*, *A. platyrhynchos*, *A. acuta*, *A. clypeata*, *Aythya ferina*, *A. fuligula*, *A. marila* and *Mergellus albellus*). Atkinson-Willes then went on to discuss the numbers and distribution of five species of seaducks (*Somateria mollissima*, *Clangula hyemalis*, *Melanitta nigra*, *M. fusca* and *Bucephala clangula*) in Europe, and defined northwest European 'populations' for these, but noted that *S. mollissima* (with several isolated and relatively sedentary populations) and *C. hyemalis* (still at that time poorly known) did not fit so neatly into the system of 'wintering regions' (Atkinson-Willes, 1978). Finally, he examined the winter distribution of the three swans *Cygnus* spp. in northwest Europe, and identified the main wintering groups of these species (Atkinson-Willes, 1981).

Detailed accounts of the populations of geese (*Anser* spp. and *Branta* spp.) occurring in the Western Palearctic have been given by Ogilvie (1978) and Timmerman (1981). More recently, Madsen (1991) has reviewed the status and trends of goose populations wintering and/or breeding in the Western Palearctic in the 1980s. He recognizes 21 populations of the eight species of geese occurring in the wild in substantial numbers, and also recognizes two populations of the introduced *Branta canadensis* (a British/Irish population and a Scandinavian population) and a feral population of *Anser anser* (in the British Isles). The present report follows Madsen (1991), except that two additional populations in Southwest Asia are included (for *Anser albifrons* and *A. anser*).

Ruger *et al.* (1986) adopted the by now traditional approach for the purposes of analysis of trends, but acknowledged that this did not necessarily reflect true biogeographical populations. They repeated the rationale of Atkinson-Willes (1976), and followed many of his 'wintering regions', adding further

justification for some of the regional boundaries. Their division of France, Germany and Spain between the northwest European and Black Sea/Mediterranean regions followed Atkinson-Willes (1976). However, these authors described more exceptions for species for which better information was then available, e.g. these authors split off the western Mediterranean population of *Tadorna tadorna* from the rest of the Black Sea/Mediterranean group on the basis of a paper by Walmsley (1984). Ruger *et al.* (1986) concluded that "the mid-winter waterfowl census data provide further support for the use of the biogeographical regions. While there is evidence of substantial internal redistribution of some northwest European waterfowl populations from year to year depending on weather conditions, large-scale movements out of the region apparently only occur in severe winters (e.g. 1978–79), when certain species, such as *Anas penelope* and *A. crecca*, move to southern Spain and probably northwest Africa".

Monval & Pirot (1989) also adopted the wintering regions as defined by Atkinson-Willes (1976), and defined the northwest European and Black Sea/Mediterranean regions rather precisely, including central Europe (southwest Germany, Switzerland, Hungary, Czech Republic, Slovakia and Austria) within the Black Sea-Mediterranean region. Both Ruger *et al.* (1986) and Monval & Pirot (1989) divided the Black Sea/Mediterranean region into two sub-regions, east and west, because of differences in the quality of the data from these two regions, and not because they thought that the birds in these two sub-regions belonged to different populations.

In their summary of waterfowl population estimates, Rose & Scott (1994) also followed the traditional approach, but made further adjustments to the limits of some populations in the light of recent information, and also made a first attempt at identifying population units in Afrotropical species.

2.5 Geographic regions not adequately discussed in previous flyway studies

i) Africa

No attempt had ever been made to define populations of endemic African Anatidae before Rose & Scott (1994), and never has any discussion or justification of population boundaries been attempted. A West African region was defined by Atkinson-Willes (1976) solely on the basis of the winter distribution of Western Palearctic species within the region, and subsequent censuses of the region were organised primarily with these species in mind. Consequently, when Perennou (1991a) analysed the results of African Waterfowl Census data for all species of waterbirds, he also chose to concur with the traditional West African region due to the consistent, long time series of data available in comparison with the rest of the continent.

In the present report, an attempt is made to identify the most appropriate population units for conservation purposes for all species of Anatidae occurring in Africa. This process has been greatly aided by the large amount of new information on African Anatidae which has become available in recent years through the African Waterfowl Census, which now covers much of the continent.

In many of the more arid regions of Africa, most species of Anatidae are known to undertake lengthy movements in response to changing water levels. In areas where rainfall is infrequent and unpredictable, these movements are also likely to be infrequent and unpredictable, and might best be described as nomadism or irregular dispersive movements. In areas where the rainfall is more or less annual and seasonal, such movements could be classified as predictable migrations, in the sense of the Bonn Convention. At the same time, in all but the most arid regions, there will be permanent wetlands at which some individuals can remain resident all year round. From the limited information available, it would seem that most populations of Afrotropical Anatidae are to some extent sedentary and to some extent nomadic or dispersive, moving in response to changing water levels. Many also undertake regular, seasonal migrations within Africa, sometimes of great length, but these movements often appear to be rather complex and, in most species, are still very poorly understood.

For many of the widespread Afrotropical species, it seems likely that there are several biogeographical populations with discrete or largely non-overlapping breeding areas and non-breeding ranges. This is particularly the case in species which have an extensive north-south range spanning the equator, since the northernmost and southernmost populations generally breed at opposite times of the year. However, until much more information becomes available on the movements of these populations, the timing of their breeding seasons, and their interactions with sedentary populations in equatorial regions, it is generally not possible to identify any particular migratory populations within the distribution of the species (or subspecies) as a whole.

Five Afrotropical species, *Dendrocygna viduata*, *Alopochen aegyptiacus*, *Plectropterus gambensis*, *Sarkidiornis melanotos* and *Nettapus auritus*, are very widely distributed over Africa south of the Sahara, and there do

not appear to be any major gaps in their distribution except in the lowland forested areas of west-central Africa and in the deserts of the southwest. Because of the extent of movements shown by these species in Africa, their entire African populations are probably best treated, biologically, as single, very large populations. However, while there would appear to be no significant barriers to movement of birds within the eastern and southern parts of the species' ranges, the lowland forests of west-central Africa and the arid regions of southern Chad and Sudan, with little suitable habitat for the species, presumably restrict movement to some extent between the West African populations and other populations.

There does indeed appear to be something of a break in the distribution of many species along a line from the Gulf of Guinea and forested highlands of Cameroon through the arid uplands of southeastern Chad and the Darfur region of western Sudan to the Nile north of Khartoum. In three species,*Dendrocygna bicolor*, *Thalassornis leuconotus* and *Anas hottentota*, there is a very pronounced break in this region. It is proposed that, for conservation purposes, a similar break be adopted along this line to create separate West African populations of the five widespread species. These West African 'populations' extend east to Chad and western Sudan, and south to the Central African Republic. It is acknowledged, however, that there may be a considerable amount of interchange between these populations and birds in eastern Africa.

While it has been argued that there is some justification for the recognition of West African populations of some Afrotropical Anatidae (as identified by Perennou, 1991a), there would seem to be little justification for the recognition of separate West African populations of Western Palearctic ducks, as identified by various earlier authors (e.g. Atkinson-Willes, 1976; Ruger *et al.*, 1986; Monval & Pirot, 1989; Perennou, 1991a). Most species of Anatidae wintering in the southern Mediterranean are also found wintering in West Africa. For species such as *Anas penelope*, *A. strepera*, *A. crecca*, *Aythya ferina* and *A. fuligula*, from Western Eurasia, wintering in West Africa is annual, but the numbers are very small and are clearly overspill from the large concentrations in the Black Sea/Mediterranean region. Clearly, the small numbers of birds reaching West Africa do not merit treatment as distinct populations. Similarly, the residue of*Anas querquedula* remaining in the Mediterranean does not warrant treatment separately from the great majority of birds which winter in West Africa. It would seem inconsistent, therefore, to treat the Mediterranean and West African wintering populations of species divided more evenly to the north and south of the Sahara as distinct. For this reason, it is recommended in the present Atlas that the 'populations' of *Anas acuta* and *A. clypeata* wintering in West Africa be combined with those wintering in the Black Sea/ Mediterranean region. Some support for this decision comes from recoveries of ringed birds which, although few in number, suggest similar origins for the birds wintering north and south of the Sahara.

ii) Africa's offshore islands

The ten species of Anatidae which breed in Madagascar are said to be mainly sedentary. Three species are confined to Madagascar and the Madagascar population of a fourth (*Thalassornis leuconotus*) is recognized as being subspecifically distinct. In the other six species, there is no indication of any interchange between the Madagascar populations and those on the mainland of Africa, except perhaps in the case of *Anas erythrorhyncha*. In all cases, therefore, the Madagascar populations of Anatidae are treated as separate populations in this Atlas.

Very few Anatidae occur on Africa's other offshore islands, except as scarce migrants or vagrants. Young (1996) summarizes the status of those Anatidae that do occur. Moreau (1966) lists only one species for the Cape Verde Islands, one for Mafia, three each for Zanzibar and Pemba, and none for the Canary Islands, Gulf of Guinea Islands (Fernando Po, Principe, Sao Tome and Annobon), Comoro Islands and Socotra. *Marmaronetta angustirostris* bred in the Canary Islands in the 19th century and probably up to about 1914, but the principal site had been largely drained by 1948, and the species has disappeared from these islands (Cramp & Simmons, 1977). *M. angustirostris* possibly also bred on the Cape Verde Islands in the late 19th century, but there have been no recent records (Cramp & Simmons, 1977). At least 14 other species of Anatidae have been recorded on the Atlantic islands off northwest Africa (Azores, Madeira, Canaries and Cape Verde), but most have been recorded only as rare vagrants, and none occur in significant numbers (Cramp & Simmons, 1977).

The occurrence of Anatidae in Zanzibar and Pemba has been summarized by Pakenham (1979). Three species have been recorded: *Dendrocygna viduata* is an occasional visitor to both islands and may have bred; *Thalassornis leuconotus* formerly bred on Pemba (until the 1920s) and has possibly occurred on Zanzibar, but there are no recent records from either island; and *Nettapus auritus* was formerly a resident on both islands, but now occurs only as a scarce resident on Pemba.

Staub & Chevreau de Montlehu (1973) refer to the occurrence of *Dendrocygna viduata* on Mayotte in the Comoro Islands, and Brown *et al.* (1982) also list *D. viduata* for the Comoros, but little information

seems to be available on this 'population', and it may be that the species occurs in the Comoros primarily as a wanderer from the African mainland.

There are very few Anatidae on the Indian Ocean islands west of the Indian subcontinent. The only Anatidae known from Mauritius are *Anas melleri*, which is believed to have been introduced from Madagascar in the mid-19th century, and *Dendrocygna viduata*, which apparently reached the island naturally and apparently breeds (Staub & Chevreau de Montlehu, 1973). At least seven species of Anatidae have been recorded in the Seychelles (including Amirantes, Farquhar and Aldabra): *Dendrocygna viduata*, *Anas crecca*, *A. platyrhynchos*, *A. acuta*, *A. querquedula*, *A. clypeata* and *Aythya fuligula*. However, all of these are vagrants except for *A. querquedula*, which occurs as an occasional passage migrant in the granitic Seychelles and as an uncommon passage migrant in the coralline Seychelles (Skerrett & Bullock, 1992).

In the South Atlantic south of the African continent, the Kerguelen and Crozet islands support extremely isolated populations of a pintail, considered by some authors to be a well-marked subspecies of *Anas acuta*, but now more widely recognized as constituting a distinct species, *Anas eatoni*, with two subspecies, *A. e. eatoni* on Kerguelen Island and *A. e. drygalskii* in the Crozet Islands. This latter treatment is adopted in the present report.

It is concluded that the only Anatidae populations on Africa's offshore islands which constitute discrete units are the populations of ten species on Madagascar, the populations of the two subspecies of *Anas eatoni* in the Kerguelen and Crozet Islands, and the introduced population of *Anas melleri* on Mauritius.

iii) Southwest Asia

Although many earlier workers had referred to the existence of a west Siberian/Caspian 'flyway' or Southwest Asian 'wintering region', it was not until the beginning of the 1990s that sufficient data were available to review the numbers and distribution of species of Anatidae within this region. In their summary of the first five years of data from the Asian Waterfowl Census (1987–1991), Perennou *et al.* (1994) recognized Southwest Asian 'populations' of 28 species of Anatidae, and considered that for conservation purposes these should be treated separately from the Black Sea/Mediterranean populations to the west and south Asian populations to the east. For most species, the Southwest Asian populations were defined as those birds wintering in the Southwest Asian region. This region was defined as the whole of the Arabian Peninsula, as well as Afghanistan, Azerbaijan, Iraq, Iran, Kazakhstan, Kirghizistan, Tadjikistan, Turkmenistan and Uzbekistan; the north Caspian region (Russia), although in Europe, was also considered as part of this region. The region did not include Turkey, Syria, Lebanon, Israel or Jordan, which had traditionally been included within the Black Sea/Mediterranean region. Perennou *et al.* (1994) noted that most if not all of the Palearctic Anatidae wintering in northeast and eastern Africa probably belonged to the Southwest Asian 'flyway', and in some cases, these authors included estimates of the numbers of birds wintering in northeastern Africa (excluding Egypt) in their population estimates for Southwest Asia.

The concept of Southwest Asian 'populations' based on a Southwest Asian wintering region (with northeastern Africa) is retained in the present report as a 'default' population for conservation purposes. There is clearly a considerable amount of mixing both between the Southwest Asian and Black Sea/Mediterranean populations, and between the Southwest Asian and south Asian populations. Evidence from ringing has shown that the vast wetlands of the west Siberian plain are a major breeding area for birds wintering in both the Black Sea/Mediterranean and Southwest Asia regions, while the wetlands of the Volga Delta in the north Caspian are a major staging area and moulting area for large numbers of birds from both these populations. Further east, there is evidence of a significant migration route through the east Caspian and wetlands of Seistan on the Iran/Afghanistan border to the wetlands of the Indus and Ganges plains in Pakistan and northern India. Finally, there is considerable overlap between the Southwest Asian and south Asian populations in the central Asian republics east of the Caspian Sea, with many birds from western and central Siberia staging in Kirghizistan, Tadjikistan, Turkmenistan and Uzbekistan on their way to winter quarters in southern Asia.

The Southwest Asian 'flyway', as defined in this Atlas, extends from the principal breeding grounds on the Taymyr Peninsula and west Siberian plain southwest through the Aral and Caspian Sea regions to western Afghanistan, Iran, Iraq, extreme eastern Turkey and the Euphrates valley, and thence southwest across the Arabian Peninsula to northeast Africa (Sudan, Ethiopia and Somalia) and East Africa (Kenya, Tanzania and Uganda). This 'flyway' population closely follows the 'West Siberian-Caspian-Nile population' described by Isakov as long ago as 1967 (see Figure 1). North of the Caucasus, the separation between the Southwest Asian and Black Sea/Mediterranean regions is set somewhat arbitrarily along the divide between the Black Sea and Caspian Sea catchments. However, in the north Caspian region,

no separation is possible because of the great importance of the wetlands of the Volga Delta as staging and moulting areas for both populations. Similarly, there is no clear separation between the Southwest Asian and south Asian populations in the central Asian republics. For the present purposes, the eastern limits of the Southwest Asian region are set along the eastern borders of Kazakhstan, Turkmenistan and Uzbekistan. The wetlands of Khirgizistan and Tadjikistan are excluded, as these are probably of greatest importance as staging and wintering areas for Anatidae in the south Asian 'flyway'.

Birds breeding and/or staging in the wetlands in the region of Lake Van in extreme eastern Turkey are included in the Southwest Asian flyway, along with the very large numbers of birds occurring in the Uromiyeh Basin just across the border in northwestern Iran. Similarly, birds breeding, staging and/or wintering in the Euphrates valley in Syria are included along with the vast numbers of birds further down the Euphrates in Iraq. Azraq Oasis in Jordan is probably best placed within the Southwest Asian flyway because of its proximity to the Euphrates valley. However, this wetland has been almost totally destroyed and now supports only small numbers of Anatidae on migration. The wetlands of the Nile Delta, although previously linked with the Caspian region in the so-called 'West Siberian-Caspian-Nile' flyway (e.g. see Isakov, 1967) are better placed within the Black Sea/Mediterranean region. There is no evidence to suggest that large numbers of birds wintering in eastern Africa enter Africa via the Nile Delta and then turn southeast to follow the Nile Valley across the desert to southern Sudan and Ethiopia. On the other hand, recent waterfowl censuses in the Arabian Peninsula suggest that many Anatidae cross the peninsula on a broad front to reach eastern Africa across the Red Sea.

In the east, the wetlands of the Seistan Basin on the Iran/Afghanistan border are included in the Southwest Asian region, as it seems likely that many of the birds which winter there in wet years (up to 1,000,000) stage in autumn and spring in the south Caspian region and Kazakhstan. (In dry years, most of these birds presumably move on to winter in the Indian subcontinent). The wetlands of central and eastern Afghanistan, which are important mainly as staging areas for Anatidae, are excluded, as it seems likely that the birds passing through these regions winter in southern Asia.

iv) Greenland

Most populations of Anatidae breeding in Greenland are either resident within Greenland (e.g. the endemic subspecies of *Anas platyrhynchos* and *Mergus serrator*), or migrate southeast to Iceland and/or northwest Europe. Both of these types of population have been included in the Atlas. However, the populations of *Somateria mollissima* and *S. spectabilis* breeding in west Greenland probably form part of much larger populations of these species in northeastern North America, and are perhaps best considered as belonging to the Nearctic/Neotropical bird migration system. For this reason, these two breeding populations have been excluded from the Atlas.

v) Iceland

The Icelandic populations of Anatidae include the full spectrum from large and definitely discrete populations to tiny, marginal populations clearly linked to northwest Europe. Two species, *Histrionicus histrionicus* and *Bucephala islandica*, are largely sedentary and occur nowhere else in northwest Europe. These clearly constitute discrete populations. The Icelandic populations of *Cygnus cygnus* and *Anser anser*, and the Greenland and Icelandic population of *Anser brachyrhynchus* winter mainly in Britain and Ireland and appear to be almost entirely separate from other populations of these species wintering on the mainland of northwest Europe. These have also traditionally been regarded as discrete populations. However, twelve species of duck which are common in northwest Europe have relatively small or very small breeding populations in Iceland. These have traditionally been lumped with the much larger northwest European populations. The species in question are *Anas penelope* (4,000–6,000 pairs), *A. strepera* (200–300 pairs), *A. crecca* (3,000–5,000 pairs), *A. platyrhynchos* (10,000–15,000 pairs), *A. acuta* (500 pairs), *A. clypeata* (10–30 pairs), *Aythya ferina* (0–5 pairs), *A. fuligula* (5,000–8,000 pairs), *A. marila* (3,000–5,000 pairs), *Melanitta nigra* (400–600 pairs), *Mergus serrator* (2,000–4,000 pairs) and *M. merganser* (300 pairs). In most cases it is clear that the Icelandic birds mix extensively with other breeding populations on their wintering grounds in northwest Europe, and presumably, therefore, show a considerable degree of genetic mixing. These populations should continue to be lumped with their respective northwest European populations. However, in some cases there would appear to be greater justification for treating the Icelandic populations as discrete populations. This is particularly the case with *Mergus merganser*, as the Icelandic population appears to be entirely resident in Iceland, with no emigration in winter, and no immigration of birds from elsewhere. The Icelandic population, although very small, is apparently quite discrete, and for conservation purposes at least should be treated as a separate group.

The population of *Mergus serrator* breeding in Iceland winters partly in Icelandic waters, where it mixes with birds from east Greenland, and partly in northwest Britain and Ireland, where it mixes with local breeders. However, the birds breeding in Britain and Ireland show only limited movements within these islands, and it may be that there is very little mixing between birds wintering in Britain and Ireland and those wintering along the coasts of continental Europe, only a few of which reach Britain (mainly in the south and east). Thus there may be some justification for treating breeding birds from east Greenland, Iceland, Britain and Ireland as a separate group from those on the European mainland.

The large Icelandic breeding population of *Somateria mollissima* has traditionally been lumped within a single, very large northwest European population of the species. This treatment is rejected in the present work because three recognized subspecies of *S. mollissima* breed in Europe, and several of the populations of these are mainly sedentary and apparently completed isolated from one another. In the revised treatment of *S. mollissima* proposed in this work, Icelandic *borealis* are lumped with *borealis* breeding in Greenland, Svalbard and Franz Joseph Land as a single European population of *S. m. borealis*, although it is acknowledged that the Icelandic birds, the Greenland birds and the Svalbard/Franz Joseph birds are unlikely to come into contact with one another, and might best be treated as discrete populations.

Recent authors have tended to treat the *Clangula hyemalis* breeding in Iceland and Greenland as being a separate population from those breeding in northern Europe and Russia and wintering mainly in the Baltic Sea. This treatment is adopted here for conservation purposes, although it is acknowledged that, in view of the species' very high mobility, there may be a considerable amount of movement between these two 'populations' and biologically it might be more appropriate to lump all *C. hyemalis* from Greenland to Siberia in a single, very large North Atlantic population (*cf. Somateria spectabilis*).

2.6 Sedentary species

No species of Anatidae are totally sedentary, i.e. never move outside their breeding territories. Even if established pairs of breeding adults are sedentary, young birds must be at least dispersive if they are to establish their own territories. Where extensive ringing has been carried out, it seems that even in sedentary species, some individuals will undertake movements of at least 100 km and sometimes up to 500 km or more. It should, therefore, be possible to define the limits of a sedentary population on the basis of the extent of these dispersive movements. Breaks between sedentary populations might be expected to occur where the gap in distribution between breeding groups is considerably greater than the distance covered in the normal dispersive movements undertaken by the species. It must be assumed that the gap between breeding groups is a genuine gap (e.g. because of the absence of suitable habitat) and not an artifact resulting from a lack of information. This approach has been adopted here, especially for Anatidae populations in Africa. Thus population units have in many cases been established primarily on the basis of known occurrences of the species (e.g. as plotted in Snow, 1978) and the likely maximum distance of normal dispersive movements, as deduced from ringing recoveries.

A more serious problem arises with species which have sedentary populations lying partly or entirely within the non-breeding ranges of migratory populations. While identification of key sites is often easy during the breeding season, when the populations are widely separated, it might be difficult or impossible at other times of the year, when large numbers of individuals from the migratory population may be present. In these cases, it is necessary to determine whether the sedentary populations in question are really 'discrete' and self-sustaining populations which have little if any genetic input from migratory birds passing through and/or wintering in their ranges, or whether they are 'marginal outliers', i.e. small parts of a much larger population exploiting isolated patches of suitable (although perhaps only marginally suitable) breeding habitat at the limit of the population's breeding range. If the former is the case, treatment of the sedentary population as a separate unit is clearly warranted. If the latter is the case, the sedentary birds should be considered as part of a larger population containing both migratory and sedentary elements. In some cases, historical information will resolve this question, e.g. when an isolated sedentary population has re-appeared again after a period of extinction, or when it is known that the breeding areas were formerly much more extensive and more or less contiguous with the main breeding areas of the bulk of the population. *Anser anser* shows both types of sedentary population in the Western Palearctic: an isolated breeding population in northwest Scotland which shows little if any mixing with the Icelandic birds wintering in Britain and may even be morphologically distinct, and a number of small breeding groups in central Europe, Turkey and Iran which mix extensively with migratory birds outside the breeding season, and probably represent no more than relicts of a once much more widespread breeding population.

TABLE 1: Anatidae populations in Africa and Western Eurasia. Population sizes, population trends and recommended thresholds for use in Ramsar Convention criterion 3c (1% level).

1% thresholds in parentheses are provisional numerical criteria for use in this Atlas, and are not intended as official 1% levels for the identification of potential Ramsar Sites.

Species	Population	Size (individuals)	Threshold used to select key sites	Trend	Sub-population
Dendrocygna bicolor	West Africa	100,000	1,000	?	
	Eastern and Southern Africa	200,000–500,000	(3,500)	?	
	Madagascar	15,000–25,000	(200)	Declining	
Dendrocygna viduata	West Africa	250,000	2,500	?Increasing	
	Eastern and Southern Africa	1,000,000–2,000,000	(15,000)	?Increasing	
	Madagascar	20,000–50,000	(350)	?Declining	
Thalassornis leuconotus	West Africa	1,000	10	Declining	
	Eastern and Southern Africa	10,000–25,000	(180)	Stable	
	Madagascar	1,000–5,000	(30)	Declining	
Oxyura leucocephala	West Mediterranean (Spain)	700	7	Increasing	
	North Africa (Algeria & Tunisia)	400	4	Stable	
	SE Europe/Turkey/SW Asia	11,000–15,000	130	?Declining	
		300–500	4	?Stable	SW Iran
Oxyura maccoa	Ethiopian highlands	1,000–5,000	(30)	?	
	East Africa	15,000–25,000	(200)	?Declining	
	Southern Africa	15,000–25,000	(200)	?Increasing	
Cygnus olor	Northwest mainland and central Europe	210,000	2,100	Increasing	
		170,000	not used	Increasing	Scandinavian/Baltic
		20,000	not used	Stable	BeNeLux countries
		16,000	not used	Stable	Central Europe
	Britain	25,000	250	Increasing	
	Ireland	10,000	100	?	
	Black Sea/E Mediterranean	45,000	450	Increasing	
	W-C Asia/Caspian Region	250,000	2,500	Increasing	
Cygnus cygnus	Iceland/U.K./Ireland	16,000	160	Stable	
	NW Continental Europe	40,000	400	Increasing	
	W Siberia/Black Sea/E Mediterranean	17,000	170	Declining	
	W Siberia/Caspian Region	(20,000)	(200)	?Declining	
Cygnus columbianus	W Siberia/NW Europe	17,000	170	?Increasing	
	N Siberia/Caspian Region	500	5	?	
Anser brachyrhynchus	E Greenland/Iceland/U.K.	225,000	2,250	Increasing	
	Svalbard/NW Europe	34,000	340	Increasing	
Anser fabalis	NE & NW Europe (*fabalis*)	80,000	800	Increasing	
	W Sib./C & SW Europe (*rossicus*)	300,000	3,000	?	
Anser albifrons	NW Siberia/NE & NW Europe	600,000	6,000	Increasing	
	W Siberia/Central Europe	100,000	1,000	Declining	
	W Siberia/Black Sea/Turkey	650,000	6,500	?	
	N Siberia/Caspian/Iraq	15,000	150	Declining	
	Greenland/Ireland/U.K. (*flavirostris*)	30,000	300	Increasing	
Anser erythropus	West Eurasia	15,000–35,000	Not used	Declining	
		3,000–5,000	40	Declining	NE and SE Europe
		10,000–30,000	200	Declining	W Siberia/Caspian

TABLE 1 ... continued

Species	Population	Size (individuals)	Threshold used to select key sites	Trend	Sub-population
Anser anser	Iceland/U.K./Ireland	100,000	1,000	Increasing	
	NW Scotland	5,250	50	Increasing	
	NW Europe/SW Europe	200,000	2,000	Increasing	
	Central Europe/N Africa	20,000	200	Stable	
	Black Sea/Turkey	25,000	250	Stable	
	W Siberia/Caspian Region/Iraq	100,000	1,000	Increasing	
Branta leucopsis	E Greenland/Ireland/Scotland	32,000	320	Stable	
	Svalbard/SW Scotland	12,000	120	Stable	
	Russia/Germany/Netherlands	176,000	1,760	Increasing	
Branta bernicla	Entire population of *bernicla*	300,000	3,000	Increasing	
	Can./Greenland/Ireland (*hrota*)	20,000	200	Stable	
	Svalbard/Denmark/U.K. (*hrota*)	5,000	50	Stable	
Branta ruficollis	Entire population	70,000	700	?	
Cyanochen cyanopterus	Entire population	5,000–15,000	(100)	Stable	
Alopochen aegyptiacus	West Africa	10,000–25,000	(175)	?	
	Eastern and Southern Africa	200,000–500,000	(3,500)	?	
Tadorna ferruginea	Ethiopia	200–500	4	?	
	NW Africa	2,500	25	Declining	
	Black Sea/E Mediterranean/NE Africa	20,000	200	?Declining	
	W-C Asia/Caspian/Iran/Iraq	35,000	350	Increasing	
Tadorna cana	Entire population	42,000	420	Stable	
Tadorna tadorna	NW Europe	300,000	3,000	Increasing	
	Black Sea/Mediterranean	75,000	750	?Increasing	
	W Asia/Caspian/Middle East	80,000	800	Increasing	
Plectropterus gambensis	West Africa (*gambensis*)	50,000	500	?Declining	
	Eastern Africa (*gambensis*)	200,000–300,000	(2,500)	Stable	
	Southern Africa (*niger*)	50,000–100,000	(750)	Stable	
Pteronetta hartlaubii	Central Africa	10,000–50,000	(300)	Declining	
	West Africa (Guinea to Ghana)	1,000	(10)	Declining	
Sarkidiornis melanotos	West Africa	50,000	500	Stable	
	Eastern and Southern Africa	500,000–1,000,000	(7,500)	Stable	
	Madagascar	10,000–25,000	(175)	Declining	
Nettapus auritus	West Africa	20,000–30,000	(250)	?	
	Eastern and Southern Africa	100,000–250,000	(1,750)	?	
	Madagascar	5,000–10,000	(75)	Declining	
Anas penelope	NW Europe	1,250,000	12,500	Increasing	
	NE Europe/Black Sea/Mediterranean	560,000	5,600	Declining	
	W Siberia/SW Asia/NE Africa	250,000	2,500	Declining	
Anas strepera	NW Europe	30,000	300	Increasing	
	NE Europe/Black Sea/Mediterranean	75,000–150,000	1,000	?Declining	
	W Siberia/SW Asia/NE Africa	130,000	1,300	?	
Anas crecca	NW Europe	400,000	4,000	Increasing	
	NE Europe/Black Sea/W Africa	750,000–1,375,000	10,500	Stable	
	W Siberia/SW Asia/NE Africa	1,500,000	15,000	Declining	
Anas capensis	Eastern Africa	100,000–250,000	(1,750)	Stable	
	Southern Africa	100,000–250,000	(1,750)	Increasing	
Anas bernieri	Entire population	500–1,000	8	Declining	

TABLE 1 ... continued

Species	Population	Size (individuals)	Threshold used to select key sites	Trend	Sub-population
Anas platyrhynchos	Greenland (*conboschas*)	15,000–30,000	(225)	Stable	
	NW Europe	5,000,000	20,000	Stable	
	N Europe/West Mediterranean	1,000,000	10,000	Increasing	
	NE-C Europe/Black Sea/East Mediterranean	2,250,000	20,000	Declining	
	W Siberia/SW Asia	800,000	8,000	?	
Anas undulata	Northeast Africa (*rueppelli*)	20,000–50,000	(350)	Stable	
	Eastern Africa (*undulata*)	50,000–100,000	(750)	Stable	
	Southern Africa (*undulata*)	60,000	600	Stable	
Anas melleri	Entire population	2,000–5,000	(35)	Declining	
Anas sparsa	Southern Africa (*sparsa*)	20,000–50,000	(350)	Stable	
	Eastern Africa (*leucostigma*)	10,000–25,000	(175)	?Declining	
	Ethiopian highlands (*leucostigma*)	2,000–10,000	(60)	?	
	Cameroon highlands (*leucostigma*)	1,000–5,000	(30)	?	
	Guinea	100	(1)	?	
	Gabon (*maclatchyi*)	1,000–5,000	(30)	?	
Anas acuta	NW Europe	60,000	600	Declining	
	Black Sea/Med/West Africa	1,200,000	12,000	Declining	
	W Siberia/SW Asia/E Africa	700,000	7,000	?	
Anas eatoni	Kerguelen (*eatoni*)	10,000–40,000	(250)	Declining	
	Crozet Islands (*drygalskii*)	1,400	14	Declining	
Anas erythrorhyncha	Southern Africa	500,000–1,000,000	(7,500)	Stable	
	Eastern Africa	100,000–300,000	(2,000)	Stable	
	Madagascar	15,000–25,000	(200)	?Declining	
Anas hottentota	West Africa	5,000–10,000	(75)	?Declining	
	Eastern Africa	100,000–300,000	(2,000)	?Stable	
	Southern Africa	100,000–200,000	(1,500)	?Stable	
	Madagascar	5,000–10,000	(75)	?Declining	
Anas querquedula	Europe/West Africa	2,000,000	20,000	?	
	W & SW Asia, NE & E Africa	100,000–200,000	(1,500)	?	
Anas smithii	Entire population	20,000–50,000	(350)	Stable	
Anas clypeata	NW Europe/Central Europe	40,000	400	Stable	
	Black Sea/Med/W Africa	450,000	4,500	?	
	W Siberia/SW Asia/E Africa	400,000	4,000	Declining	
Marmaronetta angustirostris	W Mediterranean/W Africa	3,000	30	Declining	
	East Mediterranean	1,000	10	Declining	
	SW Asia	25,000	250	Declining	
Netta rufina	C & SW Europe/W Mediterranean	25,000	250	Stable	
	Black Sea/E Mediterranean	50,000	500	Declining	
	West-central Asia/SW Asia	200,000	2,000	Stable	
Netta erythrophthalma	Entire population (*brunnea*)	30,000–70,000	(500)	?Stable	
Aythya ferina	NW Europe	350,000	3,500	Declining	
	Central Europe/Black Sea/Mediterranean	1,000,000	10,000	Declining	
	W Siberia/SW Asia	350,000	3,500	?	
Aythya nyroca	West Mediterranean/West Africa	10,000	100	Declining	
	East Europe/East Mediterranean	50,000	500	Declining	
	W & SW Asia/Northeast Africa	5,000	50	Declining	
Aythya innotata	Entire population	0–10	1	?Extinct	

TABLE 1 ... continued

Species	Population	Size (individuals)	Threshold used to select key sites	Trend	Sub-population
Aythya fuligula	NW Europe	1,000,000	10,000	Increasing	
	Central Europe/Black Sea/Mediterranean	600,000	6,000	Increasing	
	W Siberia/SW Asia/NE Africa	200,000	2,000	?	
Aythya marila	NW Europe	310,000	3,100	?	
	W Siberia/Black Sea/Caspian	100,000–200,000	(1,500)	?	
Somateria mollissima	*borealis*	675,000–1,300,000	Not used	?	
		30,000–300,000	(1,500)	Declining	Greenland
		600,000–900,000	7,500	Increasing	Iceland
		40,000–80,000	(600)	Stable	Svalbard/F Joseph
	faroeensis	18,000–26,000	Not used	?Stable	
		6,000–12,000	90	Stable	Faroe Islands
		12,000–13,500	130	?Stable	Shetland & Orkney
	mollissima	1,735,000–2,355,000	Not used	?Stable	
		65,000–75,000	700	?Increasing	Britain & Ireland
		1,350,000–1,700,000	15,000	?Stable	Baltic, DK & NL
		300,000–550,000	4,250	?Stable	Norway & Russia
		20,000–30,000	250	?	White Sea
Somateria spectabilis	E Greenland/W Siberia/NE Europe	300,000	3,000	?	
Polysticta stelleri	W Siberia/NE Europe	30,000	300	Increasing	
Histrionicus histrionicus	Greenland	1,000–2,000	15	?Stable	
	Iceland	6,000–9,000	75	?Increasing	
Clangula hyemalis	Iceland/Greenland	150,000	1,500	?Stable	
	W Siberia/NW Europe	4,600,000	20,000	?Stable	
Melanitta nigra	W Siberia/W Europe/NW Africa	1,600,000	16,000	Stable	
Melanitta fusca	W Siberia/NW Europe	1,000,000	10,000	Stable	
	Black Sea/Caspian	1,500	(15)	?	
Bucephala clangula	NW & Central Europe	300,000	3,000	Increasing	
	NE Europe/Adriatic	75,000	750	?	
	NE Europe/W Siberia/Black Sea	20,000	200	?	
	W Siberi/Caspian Region	(25,000)	(250)	?	
Bucephala islandica	Iceland	2,000	20	Stable	
Mergellus albellus	NW & Central Europe	25,000–30,000	250	?	
	NE Europe/Black Sea/E Mediterranean	65,000	650	?	
	W Siberia/SW Asia	30,000	300	?	
Mergus serrator	West Greenland (*schioleri*)	?	(100)	?	
	NW & Central Europe	125,000	1,250	Stable	
	E Greenland/Iceland/U.K.	15,000–25,000	200	?	
	NE Europe/Black Sea/Mediterranean	50,000	500	?	
	W Siberia/SW Asia	<10,000	(100)	?	
Mergus merganser	Iceland	900	9	Stable	
	NW & Central Europe	200,000	2,000	Stable	
		5,000–8,000	65	Increasing	U.K.
		3,000	30	Increasing	C Europe breeding
	NE Europe/Black Sea	10,000	100	?	
	Balkans (breeding)	50–100	1	?	
	W Siberia/Caspian Region	20,000	200	?	

3. Establishment of a Network of Protected Areas

The continued survival of many species of Anatidae in Western Eurasia and Africa is dependent on the protection and conservation of a network of wetland sites which are of critical importance as breeding, moulting, staging or wintering areas. In many parts of the region, some types of natural wetland ecosystems have now all but disappeared outside of protected areas. This is particularly the case with reed-bed ecosystems and natural flood meadows in parts of western Europe, and spring-fed marshes and shallow freshwater lakes in parts of North Africa and Southwest Asia. It seems likely that within the next two to three decades, many species of Anatidae in Western Eurasia and Africa will, at certain times of the year, have become almost confined to protected areas where they can find adequate natural foods, secure nesting and roosting sites, and freedom from persecution.

Various migration strategies can be observed among the Anatidae. During the course of their migrations, most long-distance migrants need to break their journey, often at several points, to renew their fat and protein reserves. The presence of suitable staging areas with abundant food resources is thus of crucial importance. Some species use only a very small number of sites, probably because of their highly specialized feeding and habitat requirements. These sites may be extremely important, as it seems that in many cases no other suitable staging areas are available. Thus, the loss or degradation of even one of these sites could have serious consequences for the species concerned.

The final staging area during the spring migration can be of crucial importance, especially for species breeding in the high Arctic. When these birds arrive on the tundra, feeding conditions may be poor, and the extra energy reserves obtained at the last staging area may prove vital in helping them to overcome this initial unfavourable period. In *Branta bernicla*, a correlation exists between body condition prior to departure from the Dutch Wadden Sea and breeding success in the same season (Ebbinge, 1985).

At some staging sites the turnover rate may be very high, and thus the total number of birds using the site during the course of a migration season may be much higher than the number of birds present at any one time. In the case of *Branta leucopsis* wintering in the Netherlands, it has been shown that at one particular site, although no more than 10,000–20,000 birds are present at the same time, the total number of birds which make use of the area is about 40,000, i.e. about 60% of the Dutch wintering population at that time (Ebbinge, 1985).

The period of moult, especially wing moult, is a critical time in the annual cycle of Anatidae. Food requirements are high because of increased energy demand for thermo-regulation and feather synthesis (especially in herbivorous species). There is also an increased risk of predation because of decreased manoeuvrability or even complete flightlessness. It is therefore likely that most species will have special habitat requirements during the moulting period, relating to feeding conditions and safety from predators. In a number of species of Anatidae, huge numbers of birds concentrate at a few favoured localities for the wing moult, when they become flightless. At this time, the birds are extremely vulnerable to disturbance, over-exploitation and man-made catastrophes (e.g. oil spills in coastal areas used by moulting *Tadorna tadorna*). Thus, sites with large concentrations of moulting Anatidae have an added importance.

Whether or not migratory populations of Anatidae will survive will depend on the effectiveness of the reserve networks in providing a 'green route' from breeding grounds to wintering areas via a chain of protected wetlands which can serve as moulting and staging areas. The concept that countries should work together to conserve areas that are important for the same populations of migratory species but at different times of the year is fundamental to the Agreement on the Conservation of African-Eurasian Migratory Waterbirds under the Bonn Convention. Thus, the establishment of an adequate network of protected areas to ensure the survival of migratory populations of waterfowl is a basic requirement of this Agreement. Range states should work together with international conservation bodies and funding agencies to provide funds for the acquisition and protection of critical wetland areas, to prepare and

implement management plans for these wetland reserves, and to restore degraded wetlands to their natural condition whenever possible.

Ideally, all wetlands of international importance for species of migratory and non-migratory Anatidae should be safeguarded. In some cases, because of the fragility of the ecosystem or its high importance for threatened species, strict protection may be necessary in the form of a nature reserve or wildlife sanctuary. In other cases, however, designation under the Ramsar Convention might provide an effective level of protection, and would ensure that the site receives the international attention which it deserves. Designation under the Ramsar Convention has the advantage that it does not preclude the utilization of wetland resources at these sites. In most of the developing countries of Africa, the most cogent arguments for wetland conservation relate to the high economic values of wetlands and the potential for sustainable exploitation of their natural resources which include the migratory waterfowl.

A network of wetland reserves already exists in Western Eurasia and Africa. However, the effectiveness of these reserves in protecting an adequate network of breeding, staging and wintering areas for the region's Anatidae has never been adequately assessed. One of the main aims of the present Atlas has been to determine the extent to which the various populations of Anatidae in Western Eurasia and Africa are protected within existing reserves, and thereby to assist in the identification of priorities for the establishment of further reserves. It is particularly noticeable that non-migratory Anatidae species are poorly represented by the current protected areas network.

4. Methods

4.1 Regional scope

The regional scope of this work is based on the Western Eurasian/African bird migration systems, the territorial limits being set by the limits of those populations of birds the bulk of the individuals of which spend the whole or a part of their annual cycle within Western Eurasia and/or Africa. Thus, the regional coverage closely follows that of the Agreement on the Conservation of African-Eurasian Migratory Waterbirds under the Bonn Convention.

For the purposes of this Atlas, Western Eurasia is defined as follows: the continent of Europe, including its offshore islands, from Greenland in the west to the Urals in the east; western and central Siberia east to the region of the Lena River delta (longitude 130°E); the central Asian republics of Kazakhstan, Uzbekistan and Turkmenistan; and Southwest Asia from Asia Minor through the Middle East, east to Iran and the Arabian Sea. Africa is taken to include all its offshore islands south to Kerguelen at about 50°south. Afghanistan and the central Asian republics of Kirghizistan and Tajikistan are excluded, as most of the Anatidae occurring in these countries form part of a central Asian/south Asian flyway with the principal wintering areas in the Indian subcontinent.

4.2 Taxonomic scope, treatment and nomenclature

The species and populations of Anatidae included in this Atlas are listed in Table 1. Only species and populations which are indigenous to Western Eurasia and Africa are included. Thus, species and populations which occur in the region only as a result of introductions by man (e.g. *Anser indicus*, *Aix galericulata* and the feral population of *Anser anser* in the United Kingdom) have been excluded. Similarly, species and populations which occur in Western Eurasia and Africa only at the extreme limits of their normal distribution have been excluded, as have species which occur only as rare vagrants or stragglers from other regions. Species of Anatidae which occur in Western Eurasia and Africa but have been excluded from the Atlas are listed in Table 2.

The taxonomic treatment at species level follows Sibley and Monroe (1990). Information on subspecies has been derived from a number of sources, the principal references being Brown *et al.* (1982), Cramp and Simmons (1977), del Hoyo *et al.* (1992) and Madge and Burn (1988). English names closely follow

TABLE 2: Species of Anatidae occurring in Africa and Western Eurasia but not included in this atlas

Ruddy Duck	*Oxyura jamaicensis*	Introduced into western Europe from North America.
Bar-headed Goose	*Anser indicus*	Introduced into western Europe from Central Asia; possibly also a vagrant.
Snow Goose	*Anser caerulescens*	Vagrant to Europe and Africa from North America.
Ross' Goose	*Anser rossii*	Vagrant to Europe from North America.
Canada Goose	*Branta canadensis*	Widely introduced into Europe from North America; also a vagrant.
Cotton Pygmy-goose	*Nettapus coromandelianus*	Very scarce winter visitor to the Arabian Peninsula from South Asia.
Wood Duck	*Aix sponsa*	Introduced into western Europe from North America.
Mandarin Duck	*Aix galericulata*	Introduced into western Europe from eastern Asia.
American Wigeon	*Anas americana*	Vagrant to Europe and Africa from North America.
Falcated Duck	*Anas falcata*	Vagrant to Europe and the Middle East from eastern Asia.
Baikal Teal	*Anas formosa*	Vagrant to Europe from eastern Asia.
American Black Duck	*Anas rubripes*	Vagrant to Europe from North America.
Blue-winged Teal	*Anas discors*	Vagrant to Europe and Africa from North America.
Canvasback	*Aythya valisineria*	Vagrant to Europe from North America.
Ring-necked Duck	*Aythya collaris*	Vagrant to Europe and Africa from North America.
Lesser Scaup	*Aythya affinis*	Vagrant to Europe from North America.
Spectacled Eider	*Somateria fischeri*	Vagrant to western Siberia and northern Norway from northeast Asia (east of the Lena Delta).
Surf Scoter	*Melanitta perspicillata*	Vagrant to Europe from North America.
Bufflehead	*Bucephala albeola*	Vagrant to Europe from North America.
Hooded Merganser	*Lophodytes cucullatus*	Vagrant to Europe from North America.

Sibley and Monroe (1990), although in several cases Old World names have been used in preference to the North American names advocated by these authors.

4.3 Population estimates

Unless otherwise stated, the population estimates used in this report follow recent published sources and are identical to those given by Rose & Scott (1994) in the first edition of *Waterfowl Population Estimates*. When the population estimates differ from those in Rose & Scott (1994) or more recent publications, justification for the new estimates is given in the species texts under the heading 'Population size' or in Annex 1. All population estimates and the 1% criteria derived from them are given in Table 1.

In most cases, estimates of total population size are based on the population in the non-breeding season. In some cases, the total population size has been derived from an estimate of the breeding population. In these cases, the number of individuals in the population is calculated as three times the number of breeding pairs, a formula proposed by Meininger *et al.* (1995) and adopted by Rose & Scott (1994).

For most of the populations of Afrotropical Anatidae considered in this Atlas, no reliable estimation of population size is available. In these cases, provisional criteria for site selection have been developed on the basis of a 'provisional numerical criterion'. This has been derived from a consideration of the minimum number of birds known to exist (from the African Waterfowl Census and miscellaneous individual counts) and an upper limit to the population size, derived from knowledge of the range of the species, maximum concentrations at important sites, miscellaneous national estimates of numbers, *etc.*). The provisional numerical criterion has been set at 1% of the middle of the range; thus, for example, the numerical criterion for a population estimated at between 100,000 and 1,000,000 would be 1% of 550,000 which rounded off would give 5,000. Provisional numerical criteria have also been produced for a few poorly known populations of Anatidae in Western Eurasia, mainly in Greenland.

4.4 Population trends

Table 1 also provides some information on population trends. For many of the Anatidae populations occurring in Europe and North Africa, the overall trend in numbers over the past twenty years is well documented, and the data are sufficiently comprehensive to permit the monitoring of population trends from year to year (see Rose, 1995). However, with only a few years of census data available for the great majority of wetlands in Southwest Asia and Africa south of the Sahara, it is not yet possible to determine long-term trends in the populations of most species in these regions. In sub-Saharan Africa, in particular, the existing statistical data on most migratory species and populations are quite inadequate to permit any precise statements concerning population trends during recent years. However, a considerable amount of ornithological exploration and research has been carried out in Africa since the mid-19th Century, and much of this has provided reliable, albeit anecdotal, information on the abundance of species. Much of the information on trends for African species and populations is derived from this type of information which has recently been summarized by Brown *et al.* (1982).

4.5 Selection of key sites

Numerical criteria are used to identify the key sites plotted in the species maps and listed in Annex 2.

i) The 1% criterion

The basic criterion used throughout this Atlas for the selection of key sites is the 1% criterion developed as part of a larger set of criteria for the identification of wetlands of international importance for designation under Article 2 of the Ramsar Convention. This criterion has even been used to select some key sites that are not stricly wetlands as defined by the Ramsar Convention. These criteria were adopted by the Fourth Conference of the Contracting Parties in Montreux, Switzerland, in June 1990. Within this larger set of criteria the 1% criterion is referred to as criterion 3c. This states that a wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterfowl. This 1% level (or threshold) is applicable throughout the range of that population and at any time of the year.

The philosophy of the 1% criterion and its effectiveness in the identification of key sites for migratory Anatidae in the Palearctic have been discussed at some length by Atkinson-Willes (1976) and Atkinson-Willes *et al.* (1982). Atkinson-Willes (1976) examined the effect of using numerical criteria of varying stringency to identify sites of international importance to waterfowl, and concluded that the 1% level offered much the best compromise. Criteria set at lower levels would select far too many sites for some species to be manageable, while higher levels would favour species which concentrate on a few major resorts. As this criterion has now become widely accepted as a useful tool for the identification of sites of special importance for the conservation of species of waterfowl, no further attempt will be made to justify its use here.

The Conference of the Contracting Parties in Montreux in 1990 formulated a series of guidelines for application of the Ramsar criteria. One of these guidelines states that "The specific criteria based on waterfowl numbers will apply to wetlands of varying size in different Contracting Parties. While it is impossible to give precise guidance on the size of an area in which these numbers may occur, wetlands identified as being of international importance under Criterion 3 should form an ecological unit, and may thus be made up of one big area or a group of smaller wetlands". The application of the Ramsar criteria has also recently been discussed by Stroud *et al.* (1990), Rose & Scott (1994) and Meininger *et al.* (1995).

For proper application of criterion 3c, it is essential that the term 'regularly' be defined. Atkinson-Willes *et al.* (1982) recommended that 'regularly' be defined as follows:

"A wetland regularly supports a population of a given 'size' if:

a) the requisite number of birds is known to have occurred in at least three-quarters of the seasons for which adequate data are available, the total number of seasons being not less than three.

or b) the mean of the seasonal maxima, taken over at least five years, amounts to the required level: (means based on three or four years may be quoted in provisional assessments only)."

These authors go on to say that the records on which the assessment is based should not be more than ten years old unless they belong to a continuing series or are confirmed by recent data; the months to which they refer are immaterial.

In recent years, most authors have taken an average of the annual peak numbers over the last five counts to give a five-year average (five-year mean – FYM) for use with this criterion (e.g. Ruger*et al.*, 1986; Monval & Pirot, 1989; Perennou *et al.*, 1994). Perennou *et al.* (1994) also used the frequency of occurrence of 1% or more of the individuals in a population at a site to identify international importance, although they chose the qualifying level as three years out of five, rather than three-quarters of the seasons, as proposed by Atkinson-Willes *et al.* (1982). The value of this approach is that it assists in the selection of sites which are genuinely important for a population but which fail to achieve the necessary five-year mean either because they have been counted in only three or four years, or because in one or two of the five most recent counts, coverage of the site was very poor and only a small (and therefore misleading) number of birds was recorded. In the present report, we follow Perennou *et al.* (1994) in adopting three years out of five as the qualifying level because at many of the large and important wetlands in the less well-known regions of Southwest Asia and Africa, fewer than five counts have been made and coverage is generally poor.

ii) Criteria for globally threatened species

The Ramsar criteria also contain a criterion relating specifically to rare, vulnerable or endangered species or subspecies of plants and animals. This criterion (2a) states that "a wetland should be considered internationally important if it supports an appreciable assemblage of rare, vulnerable or endangered species or subspecies of plant or animal, or an appreciable number of individuals of any one or more of these species". Although not specifically stated, it has generally been assumed that 'rare, vulnerable or endangered species' are species which have been identified as being globally threatened by IUCN in their Red Data Books. Green (1996) has recently published a list of globally threatened and near-threatened Anatidae taxa, on the basis of the new IUCN criteria for globally threatened status (Mace & Stuart, 1994; IUCN, 1994). Ten species and one subspecies of Anatidae included in the present Atlas are identified as being globally threatened by Green (1996) (see Table 3). A further species, *Pteronetta hartlaubii* of west and central Africa, is listed as being 'near-threatened', i.e. a species that is close to qualifying for one of the IUCN threatened categories.

Clearly, all sites which regularly support 1% of a population of a threatened species are of international importance (under criterion 3c), and are included as key sites in this Atlas. However, for some of the numerically more abundant species or populations, there may be many sites which regularly support an 'appreciable assemblage' of individuals of the species, but which hold less than 1% of the relevant population. Because of the globally threatened status of the species, these sites merit designation as sites of international

TABLE 3: Threatened and near-threatened species of Anatidae in Africa and Western Eurasia *(as listed by Green 1996)*

Madagascan White-backed Duck	*Thalassornis leuconotus insularis*	Vulnerable
White-headed Duck	*Oxyura leucocephala*	Vulnerable
Lesser White-fronted Goose	*Anser erythropus*	Vulnerable
Red-breasted Goose	*Branta ruficollis*	Vulnerable
Hartlaub's Duck	*Pteronetta hartlaubii*	Near-threatened
Madagascar Teal	*Anas bernieri*	Endangered
Meller's Duck	*Anas melleri*	Vulnerable
Kerguelen Pintail	*Anas eatoni eatoni*	Vulnerable
Crozet Pintail	*Anas eatoni drygalskii*	Endangered
Marbled Teal	*Marmaronetta angustirostris*	Vulnerable
Ferruginous Duck	*Aythya nyroca*	Vulnerable
Madagascar Pochard	*Aythya innotata*	Critical
Steller's Eider	*Polysticta stelleri*	Vulnerable

importance under criterion 2a. Unfortunately, no guidance has been given on interpretation of thephrase 'an appreciable assemblage'. The number of individuals or breeding pairs which constitutes an 'appreciable assemblage' of a species is likely to vary from species to species, depending on its breeding strategy, population dynamics, dispersion, migratory behaviour and so on.

With the exception of *Anas bernieri* and *Aythya innotat*a, both of which have tiny world populations and 1% levels of only 1–3 individuals, all of the threatened Anatidae in Western Eurasia and Africa have populations in excess of 10,000 individuals and hence 1% levels exceeding 100 birds. For species which are highly gregarious outside the breeding season, notably *Branta ruficollis* (population 70,000) and *Polysticta stelleri* (population 30,000), application of the 1% criterion alone will select sites holding the great bulk of the population, and there may seem little need for an additional, lower numerical criterion. However, for species with a much more dispersed distribution, notably *Oxyura leucocephala* (Southwest Asian population 11,000–15,000) and *Aythya nyroca* (east European/east Mediterranean population 50,000), strict application of the 1% criterion will select only a small number of 'super' sites, and will overlook many less important sites which cumulatively may account for a large part of the population. If adequate protection is to be given to globally threatened species through a 'key site' approach, it is apparent that a much lower numerical criterion is required if all important sites for the species are to be identified. For the purposes of the present Atlas, levels below the 1% level have been selected for globally threatened species based on the ecology and biology of the species concerned.

The rigid application of Ramsar criteria 3c and 2a, as outlined above, identifies sites which are 'known' to be of international importance for the population of waterfowl in question.

iii) Staging areas with a reasonable or high turnover rate

In its guidelines for application of the Ramsar criteria, the Conference of the Contracting Parties in Montreux in 1990 stated that "consideration may also be given to turnover of waterfowl at migration periods, so that a cumulative total is reached, if such data are available". This indicates that a site may qualify as being of international importance for a species or population if the total number of birds using that site during the course of a spring or autumn migration regularly exceeds the 1% level of the population in question. While considerable interest has been expressed in the application of this criterion, no adequate guidelines have as yet been provided for its application. In the report of van Roomen and Boere (1989) it was recommended that sites for which a moderate to high turn-over rate (during migration or moult) can be expected should be included if the number counted on one occasion is at least 75% of the 1% level. The problem with any criterion relating to turn-over rate is that it should also take into account the extent of usage of the site, and hence dependence on the site, by the birds which pass through. Highest 'turn-over' rates, and hence highest numbers of individuals, will occur at sites where birds pass through very quickly, perhaps staying only a few hours or a few days. Such sites are probably far less important for the species as a whole than those sites which are used by a lesser number of birds but for a much longer period of time, and thus constitute major staging or 'refuelling' areas for the species. In most cases, staging birds which make significant use of a site during a migration period will stay for a substantial proportion of the migration season in that region, and will thus overlap with most if not all other individuals which are also using the site for staging. This being the case, the application of the 1% criterion to the peak count during the migration period should identify most sites which are being used to a significant extent by 1% or more of the population in question.

iv) Hard weather/drought refuges

Some sites may act as important refuges during years with unusually adverse weather conditions. Under normal conditions, these sites may hold only small numbers of birds, but in certain years, very large numbers of birds may be present. Although these sites may not qualify as wetlands of international importance on the basis of the Ramsar numerical criteria, they can be of vital importance for some species in some years. Cold weather movements of eight species of Anatidae (*Tadorna tadorna*, *Anas penelope*, *A. crecca*, *A. platyrhynchos*, *A. acuta*, *A. clypeata*, *Aythya ferina* and *A. fuligula*) and the coot *Fulica atra* in western Europe have been described in some detail by Ridgill and Fox (1990). Using both waterfowl counts and ringing recovery data, these authors showed that severe weather causes movement to a differing extent in all the nine species considered. During hard weather, *Tadorna tadorna* moved out of continental coasts to Britain and possibly Ireland, while *Anas penelope*, *A. crecca*, *A. acuta*, *A. clypeata*, *Aythya fuligula* and *A. ferina* moved out of northern Britain and the Wadden Sea to southern and western Britain and northern and western France, with some species moving down into Spain and Portugal. Longer and more extensive movements occurred during the most severe conditions. Similar cold weather movements have also been documented in southwest and central Asia, the winter of 1971/72 being an obvious example in the Caspian region. Species which seem particularly susceptible to hard weather movements in Southwest Asia are *Cygnus olor*, *C. cygnus*, *Anas platyrhynchos*, *Netta rufina* and *Mergellus albellus* (Perennou *et al.*, 1994). Ridgill and Fox concluded that while it had not been demonstrated that the hard weather movements had any effect on overall population size, it would be wise to protect birds which have fled to refuge areas as a result of harsh conditions in their normal wintering ranges.

The importance of protecting sites which serve as refuges for waterfowl during periods of unusually severe weather (either cold or drought) has often been stressed. Such sites, which may hold rather small numbers in mild or average years, may provide a vital hard weather refuge for several per cent of a population during exceptionally harsh winters. The effectiveness of the 1% criterion (using either the mean of the last five mid-winter counts or requirement that the 1% level be exceeded in at least three of the last five counts) in picking out these important refuges would depend entirely on the frequency of hard winters during the period of the counts. In western Europe, periods of unusually severe weather occurred on only six occasions between 1950 and 1986, *viz.* in the winters of 1955/56, 1962/63, 1978/79, 1981/82, 1984/85 and 1985/86 (Ridgill & Fox, 1990). Obviously, a selection of sites meeting the 1% criterion on the basis of counts undertaken in the five-year period 1981/82 to 1985/86 (with three hard winters) would give very different results from a selection of sites based on counts undertaken in the five-year period 1986/87 and 1990/91 (no hard winters).

To ensure that adequate attention is given to cold weather refuges, it is recommended that the 1% criterion be extended to apply to those sites which hold over 1% of a population of a species during unusually severe winters. Criteria for establishing the severity of a winter are discussed by Ridgill and Fox (1990), but without further work their definition is hard to apply. It is difficult to know whether a winter count was undertaken within the period of harsh weather displacement and whether all species were affected. There is also no possibility for assessing drought movements easily as rainfall is often very local and unrecorded. It is partly for this reason that all sites that have ever supported more than 1% of a population are plotted and listed in this Atlas. Sites for which internationally important status can be confirmed are plotted as solid points on the maps while those that have insufficient data or irregularly support high numbers appear as scaled open circles. This at least ensures that all possible refuges are included.

v) Key sites for breeding birds

The 1% criterion is applicable year round, and applies equally to sites which hold the requisite number of individuals either during the breeding season, during the migration seasons, or in the non-breeding season. Thus, any site which holds 1% of a population during the breeding season is included in the Atlas, irrespective of whether these birds are breeding adults or non-breeding birds. Obviously in the case of species which are almost entirely sedentary, a site which holds over 1% of the population at any time of the year is likely to be internationally important as a breeding area. However, many migratory species of Anatidae, especially those breeding at temperate and northern latitudes, are widely dispersed during the breeding season, nesting around lakes, ponds, marshes, tundra pools and along sea coasts over vast areas. Breeding densities may vary considerably from one area to another, depending on the abundance of suitable wetlands, but over vast tracts of the breeding range, few if any clearly delineated 'sites' will hold a sufficiently high density to account for over 1% of the total breeding population. In such circumstances, the conservation of the species can seldom be achieved through the establishment of reserves alone, since this would require the creation of enormous reserves to protect a significant proportion of the

population. Effective conservation will be dependent on the implementation of ecologically sound land-use practices over large areas of the species' range as part of an overall land-use strategy.

For most species of Anatidae breeding at northern latitudes, the 1% criterion and the whole concept of 'site protection' is of only limited usefulness during the breeding season. Areas of exceptionally high density of breeding birds may be identified, e.g. in the case of some of the high Arctic breeding geese which nest semi-colonially, but in general, a broader environmental conservation approach will be required if the breeding populations are to be maintained. At more southerly latitudes, and especially in arid regions, wetland systems are often very large, relatively isolated from other comparable systems, and often extremely productive. At the same time, many of the Anatidae populations inhabiting these regions are relatively small. Thus in many parts of Southwest Asia and Africa, the principal wetlands are sufficiently large to support in excess of 1% of a population of one or more species. Even here, however, a large proportion of the population may move to small, seasonal wetlands to breed, and will thus not be covered by the 1% criterion approach. This is particularly the case with many of the 'rains migrants' in Africa.

There is one other major problem with the use of 1% levels to identify key breeding areas for Anatidae at northern latitudes. This springs from the fact that many of the population estimates for the more widespread species are based primarily on passage and wintering populations which do not relate specifically to any one particular breeding area. It is known, for example, that a substantial proportion of the birds in the Black Sea/Mediterranean flyway, Southwest Asian/eastern African flyway, and central Asian/south Asian flyway breed in the vast marshes in the basins of the Ob and Irtysh Rivers in western Siberia. Because of the extent of the overlap between flyways on their breeding grounds, it is impossible to decide which 1% level should be applicable. In other cases, the passage/wintering population to which a particular breeding population should be assigned remains unknown, or at best a matter for supposition. Again, there might be uncertainty as to which 1% level applies on the breeding grounds. Thus, for example, it is tempting to suppose that the small population of *Cygnus columbianus* breeding on the Taymyr Peninsula is the origin of the similar number of birds found wintering in the Caspian region. If so, a 1% level of 5 individuals applies. However, if the Taymyr birds really belong to the northwest European population, then a 1% level of 170 applies.

In view of these difficulties, no attempt has been made to identify sites of international importance for breeding Anatidae on the basis of the 1% criterion unless (a) the breeding population in question is sedentary or clearly belongs to one and only one of the passage/wintering populations; and (b) the site in question is clearly definable (e.g. a single wetland ecosystem with precise limits, an existing protected area, or an ecological unit which would be manageable as a protected area). Sites which are considered to be key breeding areas for a species simply because of the presence of unusually high densities of breeding birds have been ignored, unless the actual number of birds present is known to exceed the 1% level of the appropriate population.

vi) Provisional assessments

In many parts of Southwest Asia and Africa, even some of the most important wetland systems remain poorly known. Few if any comprehensive waterfowl counts have ever been undertaken; in some cases no counts have been undertaken for many years (e.g. in the very important wetlands of Mesopotamia, Iraq), while in other cases, it is only within the last two or three years that counting has begun (e.g. in several African countries which have only recently participated in the African Waterfowl Census). The 1% criterion can still be used to identify sites which may, on subsequent study, prove to be of considerable international importance for one or more populations of Anatidae, but because of the paucity of data, cannot as yet be confirmed as sites of international importance.

In the present analysis, poorly known sites (i.e. sites which have been counted on less than five occasions or have never been adequately censused) are provisionally identified as being of international importance for a population if they are known to have held more than 1% of a population at any time.

For many populations of Anatidae in west Asia and Africa, no reliable estimate of population size is as yet available, and hence no reliable 1% level can be used to identify sites of international importance. However, during the present analysis, an attempt has been made to give at least a 'best guess' of population size for all populations of Anatidae occurring in the region under consideration, so that some numerical criterion can be set for the identification of important sites. In some cases, this numerical criterion for site selection is merely the 1% level of the mid-point in a very broad population range reflecting the probable minimum and probable maximum sizes of the population. Clearly, any key sites identified on such provisional criteria are themselves highly provisional.

In all cases, a distinction is made on the maps between those sites which definitely meet one or more of the Ramsar criteria, and thus can be confirmed as sites of international importance in the context of

the Ramsar Convention, and those sites which should be regarded provisionally as sites of international importance, either because there are too few years of data available to confirm their importance, or because they have been selected on the basis of provisional numerical criteria.

vii) Summary of criteria

The criteria used in the identification of key sites in this atlas may be summarized as follows:

- A site is identified as being of international importance for a particular population if:
  a) the average of the peak counts in the most recent five years of counts exceeds 1% of the individuals in the population (i.e. five-year mean exceeds 1%).
  b) the 1% level has been exceeded in at least three of the last five counts. It follows that sites which have only been counted on three or four occasions will also qualify under this criteria if the 1% level has been exceeded on at least three occasions.
  c) the site regularly holds over 1% of the population during periods of unusually harsh weather (either severe cold or extreme drought). Because of the infrequency of such weather conditions and consequent low numbers of years available for analysis, 'regularly' can be taken to mean in at least two years of the most recent two or three years available.
  d) the site regularly supports 20,000 individuals from the population. (Relevant only to populations which number more than 2,000,000 individuals).
  e) the site regularly supports over 50 individuals (or 15 breeding pairs) of a globally threatened species. (Relevant only when this number is lower than the 1% level for the population).
- The site is provisionally identified as a key site for a population if:
  a) the average of the peak counts exceeds 1% of the population, but the site has been counted in fewer than five years.
  b) the 1% level has been exceeded in fewer than three of the last five years of counts.
  c) the 1% level has been exceeded in one or two years at sites which have been counted in fewer than five years. (Sites which have only been counted once and exceeded the 1% level in that year will qualify for inclusion under this criterion).
  d) the site has been selected on any of the above criteria using a provisional numerical criterion based on a rough estimate of total population size.

Table 1 gives the 1% level or threshold, based on the best estimation of population size available, for each population included in the Atlas. This 1% level or threshold has been used to select all sites that have ever been known to support this number of individuals at any time. Maximum counts, rather than average counts, have been taken as an indication of the importance of a site for a particular species, and it is the value of the maximum count that is used to scale the key site symbols on the maps. This approach has been adopted for several reasons. Firstly, very few counts have been made at many of the important sites for Anatidae in Southwest Asia and Africa, and coverage has often varied enormously. Any average count which combines the results of comprehensive aerial surveys with partial ground counts is likely to give a very misleading results. Secondly, the maximum count is more likely to indicate the importance of a site as a staging area during the migration seasons than an average count which might include many counts which did not coincide with the peak migration period. Similarly, the maximum count is more likely to indicate the importance of a site as a refuge during periods of hard weather or exceptional drought than an average count which is likely to include counts made in mild winters or wet conditions.

4.6 Information on key sites

Much of the information on key sites contained within this Atlas has been derived from the International Waterfowl Census. Since its inception in Europe in 1967, the Census has rapidly grown to encompass over 20,000 sites in over 65 countries in Western Eurasia and Africa. The databases containing the results of the Census have been used to create basic lists of all those sites which meet the numerical criteria set out above for species of Anatidae in Western Eurasia and Africa. However, these lists contain only those sites which are important during the census period (January in Europe, North Africa and the Middle East, and January and July in sub-Saharan Africa), and are very incomplete for much of Africa, where the African Waterfowl Census is still in its infancy.

Information on sites which meet the criteria at other times of the year (e.g. as moulting or staging areas), information on sites in areas poorly covered by the International Waterfowl Census, and information on the protection status of sites have been derived from a wide variety of sources. Major published sources

have included the reports of BirdLife International's Important Bird Areas projects in Europe (Grimmett & Jones, 1989) and the Middle East (Evans, 1994), the directories of wetlands of international importance in the Western Palearctic (Carp, 1980), Africa (Hughes & Hughes, 1992) and the Middle East (Scott, 1995), the directories of Ramsar Sites (WCMC, 1990; Ramsar Convention Bureau, 1993), and the IUCN directory of protected areas of the world (IUCN, 1992).

Information on key sites for threatened species of Anatidae has been taken from regional and national red data books (e.g. Collar & Stuart, 1985; Thibault & Guyot, 1988) and various species reviews and actions plans prepared within the last few years (e.g. Anstey, 1989; Green, 1993; Hunter & Black, 1995; Madsen, 1995; van Vessem, 1994). The proceedings of recent symposia on swans (Sears, 1991) and geese (Fox *et al.*, 1991) contain many papers with useful information on key sites for species in these groups, while the proceedings of the IWRB symposia held in Astrakhan in 1989 (Matthews, 1990) and Karachi in 1991 (Moser & van Vessem, 1993) include a number of papers with information on important sites for Anatidae in Russia and the new republics of the former USSR. The results of recent extensive programmes of waterfowl censuses in the Baltic (Durinck *et al.*, 1994), the Wadden Sea (Meltofte *et al.*, 1994) and Britain (Waters & Cranswick, 1993) have also been particularly valuable, as have recent, and as yet unpublished, inventories of internationally important wetlands in Latvia and Lithuania (Anon 1995a, Anon 1995b). Much of the information on key sites for Anatidae in Africa is widely scattered in the literature, although the handbook of the birds of Africa by Brown *et al.* (1982) contains a considerable amount of site-specific information, while the proceedings of an IWRB workshop on wetlands and waterbirds in eastern Africa (Finlayson & Pomeroy, 1991) include several useful summaries of key sites.

Even more important than the published literature has been the very large amount of new and hitherto unpublished information that has been provided specially for this Atlas by Wetland International's large network of contacts throughout Western Eurasia and Africa. Many national coordinators have provided up-dated lists of key sites for Anatidae in their country, while the coordinators of the Swan, Goose, Seaduck and Threatened Waterfowl Specialist Groups have provided a considerable amount of new information for the species texts and maps.

4.7 Limitations

There remain large gaps in knowledge of the status and distribution of many migratory Anatidae in Western Eurasia and Africa. Many parts of Africa and some parts of Southwest Asia still remain poorly known, and until these areas are thoroughly investigated, knowledge of the status and distribution of many species and populations will remain incomplete. The situation is particularly confusing in equatorial regions. It is known that many species of Anatidae are 'rains migrants', moving away from the equator during the rainy season to breed in seasonal wetlands to the north or south, and retreating back to the humid equatorial zone during the dry season. However, the extent of these movements, the degree of isolation between the northern populations and southern populations (which breed at different times of the year), and the extent to which these mix with or form part of the sedentary populations which remain year-round in the humid equatorial zone, are generally unknown. Basic survey work is still, therefore, a high priority, especially in central and eastern Africa.

Even in some of parts of Europe, there remains a need for basic survey work. Much more information is required on the densities of breeding species of Anatidae in the tundra and taiga zones of northern Europe, to enable the identification of areas with unusually high densities of dispersed species. There are still large gaps in knowledge of the moulting areas of some species in northern Europe and the winter distributions of several populations of seaducks.

Despite the considerable amount of bird ringing which has been carried out in parts of Western Eurasia and Africa, knowledge of the migration routes of many species and populations of Anatidae remains fragmentary. This is particularly the case with many Afrotropical species, the movements of which are still very poorly understood. This could be partly remedied by a comprehensive analysis of existing ringing data, since much of the information derived from the recoveries of ringed birds has never been properly analyzed and remains difficult to access. High priority should be given to such an analysis and publication and dissemination of the results.

There is also a need for more ringing programmes. In several key wintering areas for Anatidae in Africa and Southwest Asia, no ringing has ever been undertaken, and the local people (including hunters) have never been informed of the significance of ringed birds or what to do if they find a ring. Public awareness campaigns in these areas could greatly improve the effectiveness of ringing programmes by increasing the return rate of bird rings.

5. Species Accounts and Maps

5.1 Species accounts

The species accounts contain information under the following headings:

Subspecies: a note on the subspecies, if any.

Distribution: a brief description of the world range of the species, with special emphasis on its distribution within Western Eurasia and Africa.

Movements: information on the movements of the species in Western Eurasia and Africa, as deduced from ringing and migration studies. This information has been taken from the existing published literature, and no attempt has been made to undertake any new analyses of ringing results.

Population limits: a description of those 'populations' of the species which it is recommended should be treated as separate units for conservation purposes, with justification as far as possible on the basis of known movements of the species. In many cases, it is accepted that these 'populations' overlap extensively with other populations of the species, and cannot therefore be justified on biological grounds. Justification then rests on the desirability of dividing the individuals in a species or subspecies into geographical units which are of a manageable size for conservation purposes, i.e. the so-called 'default' populations.

Population size: an estimate of population size for each of the 'populations' identified in the foregoing section. Two types of estimates are presented: those which are considered to be sufficiently reliable to be used in the identification of Ramsar Sites on the basis of the 1% criterion, and those which are not. The latter, usually given in the form of a very broad range, are presented as 'best guesses' of population size, and are used to derive a 'provisional numerical criterion' for the identification of key sites for this Atlas. Most of the 'reliable' population estimates are taken from the published literature, and are referenced accordingly. When the estimate follows that given by Rose & Scott (1994), reference is made to the original source of the estimate, but usually no further comment is made. When the estimate differs from that given by Rose & Scott (1994), justification for the revised estimate is given either in the ensuing text or in a separate section in Annex 1. In many cases, the revised estimate has been taken from a recently published source, in which case this is clearly stated. In a few instances, particularly in some of the seaducks in northwest Europe, the justification for the revised estimate is (at the time of writing) still in press. Justification for the provisional estimates, most of which are completely new, is given in the ensuing text. In many cases, these estimates are based on the range categories given by Rose & Scott (1994), but have been refined on the basis of consultation with experts in the appropriate regions and recent census data.

Habitat/ecology: a brief note on habitat preference, social behaviour, moult, timing of the migrations, and any special features, such as unusual feeding habits, which might be of vital importance in the design and management of a suitable network of reserves.

Conservation status: a summary of information on trends in the population or populations. For many of the Anatidae populations occurring in Europe and North Africa, trends in numbers over the past twenty years have been well documented. In these cases, only a short note is given on trends, appropriately referenced. However, in much of Southwest Asia and Africa south of the Sahara, only a few years of census data are available. In sub-Saharan Africa, in particular, the existing statistical data on most migratory species and populations are quite inadequate to permit any precise statements concerning population trends during recent years. In these cases, the remarks on trends have been based on

information in the published literature (often somewhat anecdotal) and comments received from Wetland International's network of contacts in the region. For most species, this section consists of only one or two paragraphs describing population trends, with appropriate references. However, in the case of globally threatened species and species with small populations which are declining rapidly, some attention is given to threats to the population and possible causes of any decline.

Network of key sites: A brief appraisal of the value and completeness of the key sites listed in Annex 2 is given and major gaps are highlighted.

Protection status of key sites: The protected status of key sites is very briefly summarised, with particular attention being placed on gaps in the protection of the key sites networks.

5.2 Maps

For each species included in this Atlas, a map is given showing the approximate limits of the populations as identified in the text. Population boundaries are solid lines when they delineate populations that are totally discrete or almost so, and broken lines when they delineate regional assemblages of birds that regularly exchange individuals with adjacent assemblages (the 'default' populations). Dotted lines are used when there is a high degree of uncertainty as to where the best dividing line between two adjacent assemblages might be. Thus dotted lines are often used to delineate the main breeding ranges of migratory Palearctic ducks when there is known to be a considerable amount of overlap between different 'populations' on their breeding grounds.

The population limits as shown on the maps are intended to indicate the main range of the population in question, and do not necessarily indicate the total range of the individuals in that population. When small numbers of birds regularly undertake lengthy movements to areas outside the main range of the population, these movements are indicated with arrows.

Breeding ranges are indicated with orange shading. This is restricted to the Western palearctic as breeding distributions are not adequately known for most African species.

All key sites are plotted as circles scaled according to the size of the maximum count expressed as a percentage of the population estimate. This ensures that a site supporting 1% of the individuals in a small population is given equal representation to a site supporting 1% of a large population, and therefore considerably more individuals.

All key sites selected on the basis of a 1% threshold level or a provisional numerical criterion are plotted on the maps. Sites represented by solid circles are sites which are known to fulfil the requirements of the Ramsar criteria, and can therefore be confirmed as sites of international importance for the species in question (i.e. sites at which the average count over five or more years exceeds the threshold, or sites which have held more than the threshold level on three or more of the last five counts). These sites have not necessarily been designated to the Ramsar List. Sites represented by open circles are sites which either: (a) have been counted on too few occasions, i.e. are data deficient; (b) fail to meet the definition of 'regularly' as used in this Atlas; or (c) have been selected on the basis of a provisional numerical criterion. Such sites are provisional sites of international importance. Full details of the key sites can be found in Annex 2.

No attempt is made on the maps to indicate the protection status of key sites. This information can be found in Annex 2.

5.3 Key to maps

Shading

For Western Palearctic breeding species, the known breeding areas are shaded in orange. This is not repeated for Afrotropical species because breeding ranges are often either poorly known or they are not discrete for the nomadic species.

Boundaries

The boundaries of populations are represented by solid or dotted orange lines. Other colours are used if population boundaries overlap substantially. The boundaries are solid if they are based on good biological data. If the boundaries are relatively unknown or have very little biological significance they are

represented by dotted lines. Virtually all of the population boundaries crossing northern European breeding grounds are dotted in nature. When there is substantial overlap of populations, boundary lines are presented in contrasting colours.

Symbols

All key sites identified from available breeding, passage, staging, moult and wintering data are represented as scaled circles. These are open if data is lacking or if the site can only be shown to support internationally important numbers of waterbirds irregularly. Closed circles represent sites that regularly support more than 1% of the estimated size of the population. The circles are scaled according to the size of the maximum count at the site. There are four sizes of circle. The largest circles are for sites that have supported 10% or more of the population at any one time. The intermediate two sizes are for sites that have supported 1%–2% or 2%–10% of the population and the smallest circles are for sites that are internationally important because the species is globally threatened or because they support more than 20,000 individuals of the population. Sites represented by the smallest circles have never supported as many as 1% of the population.

Scale and projections

The scale and projection of the maps is chosen independently, according to the range and distribution of the populations.