Introduction

Waterbirds[1] occur on wetlands, often in spectacular concentrations, and are one of the most obvious indicators of the richness and diversity of these productive ecosystems. The long migrations of some waterbirds, and the fact that some species are the prized quarry of hunters, have made these birds a favoured subject for research, survey, education and recreation throughout the world. Networks of experts on every continent contribute to co-ordinated waterbird monitoring programmes, making waterbirds one of the most comprehensively studied groups of animals on earth, and the first to be mentioned in the title of an important inter-governmental treaty: "The Convention on Wetlands of International Importance, especially as Waterfowl Habitat", now better known as the Ramsar Convention on Wetlands.

Objectives of *Waterbird Population Estimates*

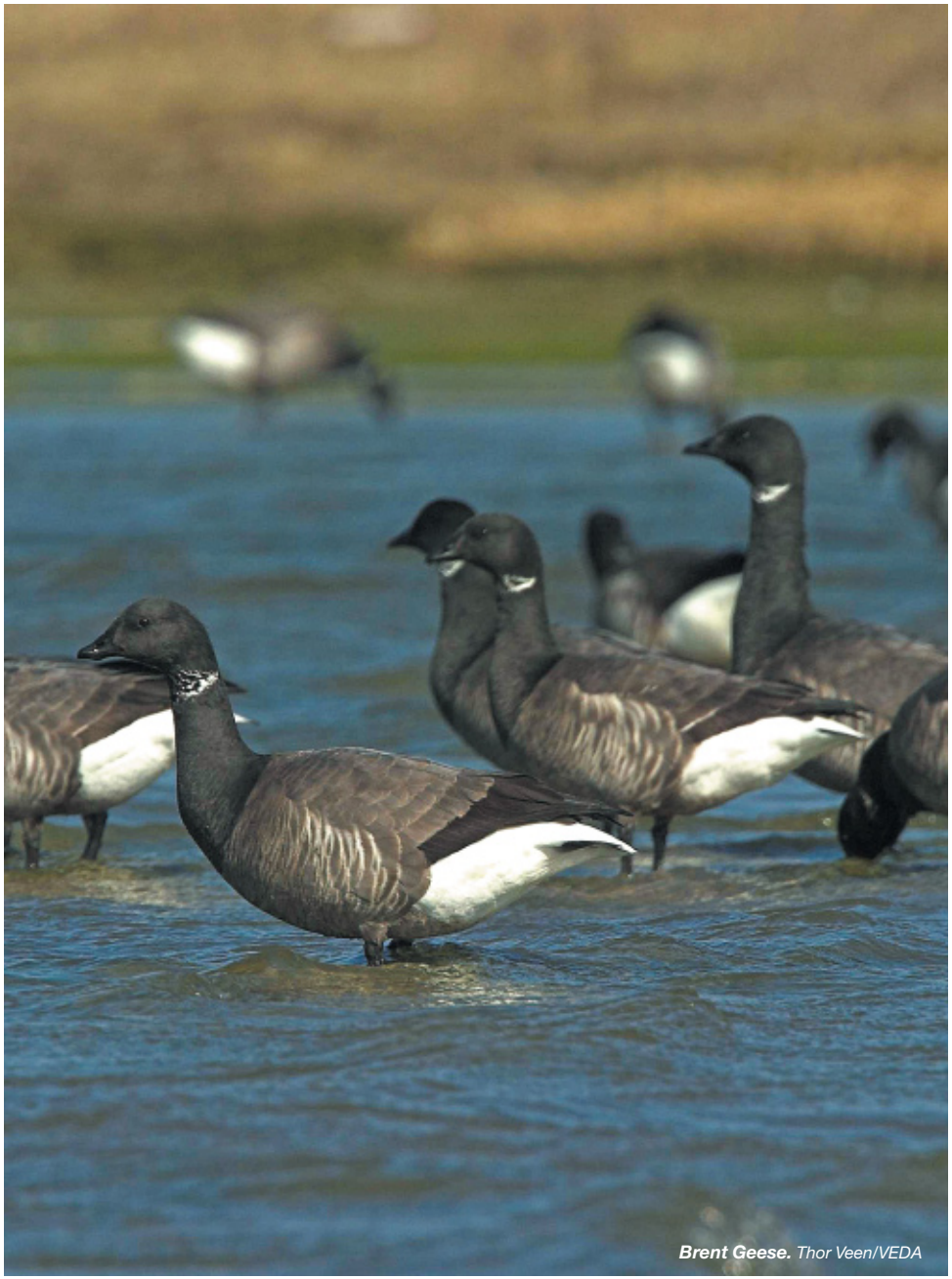
The first edition of *Waterfowl Population Estimates* (Rose and Scott 1994) provided a first global overview of the status of the world's waterbird populations. It was prepared with four objectives, and these objectives have not changed in subsequent editions:

(i) to assist in the identification of wetlands of international importance using waterbirds as bio-indicators, and especially to provide the basis of the so-called 1% criterion, whereby any site which regularly holds 1% or more of a waterbird population qualifies as being internationally important under the Ramsar Convention on Wetlands;
(ii) to identify priorities for conservation and research to maintain global waterbird biodiversity;
(iii) to identify gaps in knowledge of the world's waterbird populations; and
(iv) to support the development of the Ramsar, Bonn and Biodiversity Conventions.

Background to the Fourth Edition

The third edition of *Waterbird Population Estimates* (Wetlands International 2002) included much the same information as the first and second editions (Rose & Scott 1994, 1997) but more information was provided in the tables, particularly about the sources of information. Distribution maps for all species were also included, generously provided by the editors and publishers of the *Handbook of the Birds of the World* (del Hoyo *et al.* 1996 & 1999). Other new features of the third edition included English vernacular names for all species and some distinctive subspecies, and short descriptions of both the breeding and non-breeding ('wintering' or 'contra-nuptial') ranges of all populations, insofar as these are known. A 'Notes' column was also added to the tables, and this

1 The term 'waterbirds' has been adopted by Wetlands International in preference to the term 'waterfowl' because of the different meanings of that word in different parts of the English speaking world.



Brent Geese. *Thor Veen/VEDA*

permitted the presentation of many more explanatory notes, particularly with regard to taxonomic treatment and the derivation of population estimates. This fourth edition has continued with these improvements but resources have not allowed further development.

Sources of information

Since the third edition of *Waterbird Population Estimates* was published, a great deal of new information on waterbird populations has become available. The International Waterbird Census (IWC), co-ordinated by Wetlands International, now covers over 100 countries in five continents, and continues to provide much of the raw data on which many of the estimates and trends are based. Additional census schemes, atlas projects and one-off surveys have contributed a wealth of new information on population sizes in many parts of the world. Some of the most significant sources of information which became available between 2002 and 2006 included:

- El Censo Neotropical de Aves Acuáticas (López-Lanús & Blanco 2005).
- North American Waterfowl Management Plan, 2003.
- Population estimates of North American shorebirds, 2005. (Morrison *et al*. 2005).
- Waterfowl Population Status, 2005. US Department of the Interior, Washington, D.C. (U.S. Fish & Wildlife Service. 2005).
- Numbers and distribution of Waterbirds and wetlands in the Asia-Pacific Region. Results of the Asian Waterbird Census 1997-2001 (Li & Mundkur, 2004).
- Shorebirds of the Yellow Sea, Importance, Threats and Conservation Status (Barter 2002).
- Migratory Shorebirds of the East Asian-Australasian Flyway; Population Estimates and Important Sites (Bamford *et al*. in prep).
- Preliminary estimates of population sizes of Australian waterbirds, including EPBC-listed species. (Jaensch, 2003).
- Status of Breeding Seabirds in the Red Sea and Gulf of Aden. PERSGA Technical Series No. 8. PERSGA, Jeddah. (PERSGA/GEF, 2003).
- African Waterbird Census / Les Dénombrements d'Oiseaux d'Eau en Afrique. 1999, 2000 and 2001. (Dodman & Diagana 2003).
- Roberts – Birds of Southern Africa, 7th ed (Hockey *et al*. 2005).
- An analysis in autumn 2005 of waterbird trends in Europe, using TRIM, on International Waterbird Census data, posted on the Wetlands International website at:. http://www.wetlands.org/listmenu.aspx?id=56f39008-f9a9-4569-92c1-a0457e95eeaf (Wetlands International unpublished data 2005).
- Birds in Europe, population estimates, trends and conservation status (BirdLife International 2004).
- Breeding Waders in Europe 2000 (Thorup, 2005).
- The Herons *Ardeidae* (Kushlan & Hancock, 2005).
- Ducks Geese and Swans (Kear, 2005).
- Proceedings of the Fourth International Swan Symposium, 2001 (Rees *et al*. 2002).
- Threatened birds of the world, 2005 Species factsheets available at www.birdlife.org (BirdLife International 2005).

In addition to these sources, a literature review resulted in 583 published and unpublished sources (listed on pages 216–230) being used to compile the population estimates and trends presented.

Wetlands International's Specialist Groups have provided valuable updated information on many populations. For this fourth edition, the Flamingo Specialist Group provided details of a complete review of the world's flamingos, including a modernisation of taxonomy. Cooperation with BirdLife International has resulted in the inclusion of up-to-date information on Globally Threatened species, and the 2004 BirdLife publication *Birds in Europe: population estimates, trends and conservation status* was a source of many new estimates.

Ensuring a flow of up-to-date information to the compilers was a major networking exercise in which Wetlands International's regional offices in Buenos Aires, Brisbane, Canberra, Kuala Lumpur and Dakar played a crucial role. In North America, fruitful relations were maintained with the Mid Atlantic Coordinator of the Atlantic Coast Joint Venture of the U.S. Fish and Wildlife Service, who ensured that experts on all waterbird groups were consulted, and their expertise included.

The compilation of information for this edition of *Waterbird Population Estimates* coincided with the compilation by Wetlands International of information for the third edition of the *Report on the Conservation Status of Migratory Waterbirds in the Agreement Area* (Wetlands International 2005) for the Third Meeting of the Parties to the African-Eurasian Migratory Waterbird Agreement (AEWA) in Dakar, Senegal, in October 2005. This report contains many new estimates derived from a number of published sources, and constitutes a valuable source of additional information on the numbers and trends in populations of migratory waterbirds in Africa and Western Eurasia.

Improvements on earlier editions

It had already become apparent, even before the second edition of *Waterfowl Population Estimates* was produced, that interpretation of the geographical descriptions of the populations was probably the commonest source of confusion when applying 1% thresholds to identify wetlands of international importance. For the third edition, and for this fourth edition, wherever possible a brief description of both the breeding and non-breeding ('wintering' or 'contra-nuptial') ranges of migratory populations has been included. It is hoped that these range descriptions at the population level, along with the distribution maps, at species level, will help to alleviate this problem. The actual biogeographic ranges of individual populations are, however, often difficult to define, and the boundaries between adjacent 'flyway' populations are often imprecisely known, especially when these populations overlap at some stage during their annual cycle. Only when the limits of each population have been shown on a map will it be possible to determine with any certainty the full suite of range states that are included in each population. The provision of maps showing the limits of individual populations is clearly

a priority for the future. A start has been made with addressing this priority by the publication of Flyway Atlases (e.g. Scott & Rose 1996, Miyabayashi & Mundkur 1999). At least one further Flyway Atlas is in preparation, covering waders (shorebirds) in Africa and western Eurasia and the production of similar atlases for additional species in this part of the world is identified as being important in the AEWA Implementation Priorities. The *Waterbird Population Estimates* project has a bright future on the internet, where digital formats have obvious advantages in the presentation of spatial data, which will further enhance its use for the identification of internationally important sites.

Constraints

The task we have set ourselves in assessing global population sizes of all waterbirds is a difficult one, described in the introduction to Morrison *et al.* (2001) as "the process of attempting to know the unknowable". Hugh Boyd in the Foreword to the 1999 publication *Population modelling and management of Snow Geese* expressed the dilemma faced by scientists attempting to present the information needed by policy makers and others involved in the conservation and management of these populations: "Many other considerations in addition to scientific ones are involved in scientific policy making and decision making. Scientists can play their part by providing the best available information and advice. That will rarely be as complete and reliable as they would wish, but making a "best guess" is much better than remaining aloof because perfection has not been achieved".

Our aim has been to use the best available information to set the global standard for knowledge of waterbird population estimates and trends. This publication also highlights gaps in our knowledge of the world's waterbirds and should be used to prioritise further research and survey. Many waterbird populations are poorly known or of unknown size, and for many more, knowledge of whether numbers are stable, declining or increasing is lacking. The biogeographical delimitation of populations is itself often a difficult exercise, and the identification of populations beyond the subspecies level will often be open to reinterpretation in the light of improved knowledge. Wetlands International is committed to deliver the best information and advice available within the limit of available resources. The widest possible consultation of people-networks and published sources has guided the estimates presented in this book. We invite anybody that feels well-placed to contribute to the improvement of these figures to provide information and become involved in the continuing process of revising and refining the information presented.

The Ramsar Criteria and 1% thresholds

The Ramsar Convention (Convention on Wetlands of International Importance especially as Waterfowl Habitat, Ramsar, 1971) has become an important tool by which governments agree common standards for the conservation and wise use of wetlands. One mechanism by which this is achieved is the designation of internationally important wetlands to the Ramsar List. These so-called 'Ramsar sites' must meet at least one of eight criteria by which the wetland can be adjudged to be of international importance. Applying most of these criteria relies on expert judgement. However two of the criteria, which relate specifically to waterbird populations, are more objective and have been very widely applied.

The first of these waterbird criteria, Criterion 5, states that "a wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds". The second, Criterion 6, 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 waterbird." Of the two criteria, Criterion 5 is the most simple to use, requiring no additional information beyond that which can be collected at the site itself. Criterion 6 is also easy to apply, although it requires a numerical estimate of population size to be available for the appropriate waterbird species or population to act as the basis of a 1% threshold. A major aim of this publication is to provide the quantitative information necessary for the use of Criterion 6. It draws together existing population estimates of the world's waterbirds, and sets the 1% thresholds that are to be used in the application of Criterion 6 in the designation of sites under the Ramsar Convention.

It is generally accepted that the 1% thresholds used to apply Criterion 6 are most useful if they are not changed too frequently, even though the population estimates on which they are based will change, both through improvements in the understanding of the populations and through real changes in population size. It is important that there is an agreed mechanism for changing the 1% thresholds for the application of Criterion 6. The following guidelines have been suggested:

1. Changes to 1% thresholds for application of Ramsar Criterion 6 should not be made for variations in population status within agreed limits of natural fluctuation. In this respect, all future analysis and discussion of waterbird population status should, wherever possible, try to define limits of natural fluctuation.
2. Published population estimates from a technically competent source should be the only justification for changing the 1% thresholds for application of Ramsar Criterion 6 suggested in this publication and in subsequent updates.
3. 1% thresholds for application of Ramsar Criterion 6 should be suggested for waterbird populations of unknown or poorly known status as soon as suitable information becomes available, through the triennial update of this publication.

Sine Saloum Ramsar site, Senegal. *Simon Delany*

4. Wherever possible, population estimates and 1% thresholds of well monitored species should be reviewed on a regular (nine yearly) basis.

In Resolution VI.4 of the 6th Meeting of the Conference of the Contracting Parties to the Ramsar Convention, the Conference of the Contracting Parties agreed, *inter alia*, that "unless waterfowl populations are poorly known or are known to be rapidly changing, 1% threshold levels should be revised not more frequently than every third ordinary meeting of the Conference of the Contracting Parties", and called on Contracting Parties to use these estimates and thresholds, upon their publication, as a basis for designation of sites for the List of Wetlands of International Importance in the succeeding three triennia. In the absence of definitions of the terms "poorly known" and "rapidly changing", however, it has in practice been difficult to judge when to change 1% thresholds. In each edition of Waterbird Population Estimates (with occasional exceptions, documented in the "Notes" column) the 1% threshold presented for each population is 1% of the estimate presented, regardless of how well known or how rapidly changing the population actually is.

In practice, there are rather few well-monitored populations outside Europe and North America, and many of the revised estimates given in this edition of *Waterbird Population Estimates* reflect an improvement in knowledge, rather than any known change in population size. There is a general tendency for estimates to increase as knowledge of populations improves, and this can lead to an anomalous situation where a population may be known to be decreasing, but where improved knowledge of numbers leads to an increase in the estimate presented since the previous editions of *Waterbird Population Estimates*.

Application of the 1% criterion has already been extensively discussed by Atkinson-Willes *et al.* (1982) and Stroud *et al.* (1990), and guidelines for the application of the criterion have been provided by the Ramsar Convention Secretariat and are available on its web site. Once a site has been delimited, the number of birds of each population occurring regularly at the site can be compared with the thresholds given in the tables which form the bulk of this publication. If the site regularly supports more than the given 1% threshold for any population, it is considered to be internationally important for that population.

Migratory waterbirds pass through many wetlands *en route* to their breeding or wintering grounds, and, although the number of waterbirds present at any one time may never exceed the 1% threshold, the wetland may still support internationally important numbers of a population because of the total number of birds which use the site during the whole migration period. This can only be substantiated by an estimation of the rate at which the individuals present are changing (turnover rate). Special techniques, such as direct observation of migratory flocks, or indirect observation through studies of marked (ringed) individuals, are usually required to measure turnover. The Ramsar Convention urges the use of turnover estimates, where these data are available, in application of Criterion 6.

If, at any time, a site supports two populations of the same species, problems in applying Criterion 6 can arise if individuals of the two populations are indistinguishable. In such cases, every effort should be made to apply the appropriate 1% threshold to each population by investigating the origin and destination of individuals at the site, or through determining the seasonal patterns of occurrence for each population using the site. Meininger *et al.* (1995) suggested that when two or more populations of a species occur at a site and separation is impossible, the 1% threshold relating to the largest population should be used for site designation purposes.

Methodology

What are waterbirds?

The Ramsar Convention defines 'waterfowl' as species of birds that are "ecologically dependent upon wetlands" and has defined "waterbird" as being synonymous with "waterfowl" for the purposes of the application of the Convention. However, in the second edition of *Waterfowl Population Estimates*, 'waterfowl' were defined more precisely as all species of the families Gaviidae, Podicipedidae, Pelecanidae, Phalacrocoracidae, Anhingidae, Ardeidae, Balaenicipitidae, Scopidae, Ciconiidae, Threskiornithidae, Phoenicopteridae, Anhimidae, Anatidae, Pedionomidae, Gruidae, Aramidae, Rallidae, Heliornithidae, Eurypygidae, Jacanidae, Rostratulidae, Dromadidae, Haematopodidae, Ibidorhynchidae, Recurvirostridae, Burhinidae, Glareolidae, Charadriidae, Scolopacidae, Thinocoridae, Laridae, Sternidae and Rynchopidae. Only a minority of wetland bird populations are excluded by this approach. Conversely, the inclusion of whole families resulted in the waterfowl list containing a few non-wetland species such as some seabirds and stone-curlews. These rather minor anomalies were thought to be outweighed by the convenience of a whole-taxon approach to the definition of 'waterfowl' and, in particular, considering the complications that would arise from applying the definition rigidly to every species.

This edition of *Waterbird Population Estimates* considers the same families of birds as were covered in the three earlier editions. However, the term 'waterbird' implies a broader meaning than the strict definition of 'waterfowl' given in the second edition, and more in keeping with the Ramsar definition of 'waterfowl', *i.e.* birds that are ecologically dependent on wetlands. Many participants in the International Waterbird Census already submit counts of wetland birds additional to the families listed above, and it has been proposed that future editions of *Waterbird Population Estimates* should include population estimates for these, wherever possible. One of the most logical expansions would be to include additional families of birds traditionally regarded as seabirds. Many of the species of 'waterbirds' currently included in *Waterbird Population Estimates* are strictly marine species that would equally merit the name 'seabird', notably many species of cormorants (Phalacrocoracidae), gulls (Laridae) and terns (Sternidae), while many of the 'seabirds', currently excluded, might equally be termed 'waterbirds', as they make extensive use of shallow, inshore waters. Of the seabird groups, perhaps only the four families of Procellariiformes (Diomedeidae, Procellariidae, Hydrobatidae and Pelecanoididae) do not include any species that can be regarded as waterbirds. A majority of species in these families are exclusively pelagic away from the breeding sites, rarely straying into inshore waters except when storm driven. At least some of the species in the other 'seabird' families (Spheniscidae, Phaethontidae, Sulidae, Fregatidae, Stercorariidae and Alcidae) make use of shallow, inshore waters, and could therefore be considered 'waterbirds' appropriate for inclusion in *Waterbird Population Estimates*. It has therefore been proposed that, for the sake of consistency, future editions of *Waterbird Population Estimates* should include at least these groups of seabirds.

Spoon-billed Sandpiper. *Chris Schenk*

The first three editions of *Waterbird Population Estimates* were restricted to native populations of waterbirds occurring in a natural, wild state, and did not include those populations of waterbirds that have been introduced outside their natural range, either deliberately or accidentally, by humans. This approach has been retained in the present edition. However, it is now recognised that some artificially introduced populations of waterbirds can have a negative impact on native populations of other species. The accidental introduction of the North American Ruddy Duck *Oxyura jamaicensis* into the wild in Europe and the threat which this is now posing to the already Globally Threatened White-headed Duck *Oxyura leucocephala* has been well documented. It has therefore been proposed that future editions of *Waterbird Population Estimates* will include established populations of non-native waterbirds, so that their status can be monitored more closely. Established populations of non-native species could be defined as those populations that have been self-supporting in the wild state for at least 10–15 generations, to exclude those frequent but unsuccessful breeding attempts by recent escapes from captivity. All participants in the International Waterbird Census are encouraged to submit counts of non-native waterbirds, and contributors to the fifth edition of *Waterbird Population Estimates* will be requested to provide estimates for these populations. For such populations, however, 1% thresholds will not be published, since the Ramsar Convention has indicated (Resolution VII II) that such non-native species should not be used as part of a supporting case for classification of a wetland of international importance.

What is a waterbird population?

For a full and detailed discussion of this question, readers are referred to the introductory chapters of the *Atlas of Anatidae Populations in Africa and Western Eurasia* (Scott and Rose 1996; see: http://www.wetlands.org/oldsite/IWC/wpal&swa/atlas/Introchp.pdf) A waterbird population can be defined as a distinct assemblage of individuals which does not experience significant emigration or immigration. This definition can only be fulfilled if the interchange of individuals between populations remains at a low level. The degree to which exchange of individuals occurs will determine gene flow and hence the justification for recognising subspecies or merely populations.

Given the current information available for waterbirds, it is rarely possible to define ideal populations. There is often overlap of populations at some stage of the annual cycle, and it is even possible for populations to mix yet maintain independence through behavioural isolating mechanisms. Many species have a limited geographical range and can be considered as one population, while others have a cosmopolitan distribution making the consideration of one population inappropriate for conservation and management purposes. For these species, biogeographic units have to be defined taking into consideration all aspects of biology and the practicalities of conserving the populations. In these cases it is often beneficial to use a particular geographic region for more than one species (e.g. East Asia/Australasia, Northwest Europe, Southern Africa). To date, the term ‘flyway’ has most commonly been used to describe zones common to many species, based on the approximate separation of populations. Within this publication, biogeographic populations have been defined, as far as possible, on the basis of the biology of each species, although it has been necessary to present data using traditional ‘flyway’ boundaries where more precise information is lacking.

For sedentary species it becomes more difficult to apply the definitions suggested for populations. It is often possible to demonstrate that the dynamics of almost every population fragment are relatively independent of each other. This is especially true for sedentary island populations. In such situations, these smaller populations are best considered as part of a more extensive meta-population. The alternative is to treat every sedentary species as one population which is often equally difficult to justify. In the absence of practical guidelines or principles for defining populations of sedentary species, decisions have been made according to subspecific divisions (usually following del Hoyo *et al.* 1992 and 1996) and with respect to practical implementation of the 1% thresholds. Some anomalies still occur in the treatment of sedentary waterbird species in this publication because of differences between species in morphological variation and consequent taxonomic treatment. For example, the Striated Heron *Butorides striatus* is a sedentary species that exhibits a high degree of morphological variation over its very wide range. Over 30 subspecies have been described, and 23 of these are widely recognised. In this case, estimates (where available) have been provided for each distinct subspecies in line with current taxonomic understanding.

How to use this book

Data presentation

In order to avoid misinterpretation of the tables, we strongly recommend that the following section on data presentation is read thoroughly before the tables are consulted. The results for each waterbird family are presented in the tables. The nature of this publication requires that a great deal of information is presented in a limited amount of space. Despite the care taken to present the data in a way that minimises the possibilities for misinterpretation, some important general clarifications are necessary. The greatest problems are likely to be encountered in determining the geographical limits of a population from the necessarily very concise range descriptions given in the tables.

The data in each column of the tables are presented in a standardised way wherever possible. This process is described for each data category (column) of the tables in the following subsections. Throughout the tables, a primary source reference has been given for each population estimate and trend. Whenever the estimate or trend has been derived from two or more sources, codes for all sources are given and an explanation is given in the Notes column.

Table headers

The Table headers include the scientific and English names of each species. A colour-coding system is used to indicate the IUCN threat status of each species, as follows:

Blue header – Species not known to have unfavourable conservation status

Red header – Globally threatened species. IUCN threat status appears after the scientific name, using the following codes:

CR Critically Endangered
EN Endangered
VU Vulnerable

Orange header – Threatened species considered to be at lower risk of extinction. IUCN threat status appears after the scientific name, using the following codes:

CD – Conservation Dependent, NT – Near Threatened
Also included under orange headers are species in the following IUCN threat category: DD – Data Deficient

Black header – Extinct species.

For details of the threat status categories, readers are referred to Hilton-Taylor (2000) and BirdLife International (2000).

Maps

Global distribution maps at species level from *Handbook of the Birds of the World*, Volumes 1 and 3 (del Hoyo *et al.* 1992, 1996) have been generously provided by the publisher, Lynx Edicions. The purpose of the maps is to illustrate the geographical range occupied by each species, although the small size of the maps does not allow extreme precision. The maps show the natural range of each species and do not include populations that have been introduced outside their natural range. There are two exceptions to this: Canada Goose *Branta canadensis* and Black Swan *Cygnus atratus.* Three colours are used on the maps: yellow represents the geographical area normally used by the species for breeding, blue represents the geographical area used outside the breeding season, and green indicates areas where the species is present all year round. Arrows are used to prevent small areas isolated from the main range (especially small islands) passing unnoticed. A few of the species do not have their own maps because of occasional differences in taxonomic approach between *Waterbird Population Estimates* and *Handbook of the Birds of the World.* These species usually have their ranges included on the map of the preceding species, and information in the Notes column gives details of the difference in taxonomic approach. A small number of waterbird species have been discovered and described since publication of *Handbook of the Birds of the World*, and for these it has not been possible to provide maps.

Scientific names

The sequence of families and the treatment at species level follow the *Handbook of the Birds of the World* (del Hoyo *et al.* 1992, 1996) except for two families. Treatment of the grebes follows the sequence preferred by the Grebe Specialist Group (O'Donnell & Fjeldså 1995). Nomenclature and population analysis of the herons follow the approaches of the Heron Specialist Group developed during preparation of the *Action Plan for Herons of the World* (Hafner *et al.* 2003) which incorporated advances in heron taxonomy and phylogeny, especially molecular studies (McCracken and Sheldon, 2002). This approach was made generally available in a new monograph of the heron family in 2005 (Kushlan & Hancock 2005). This treatment of taxonomy and nomenclature is very similar to that adopted by BirdLife International, and a number of small changes were made to this edition of Waterbird Population Estimates to bring it even more closely into line with BirdLife's World Birds Database, which is kept under review by the BirdLife Taxonomic Working Group.

English names

English vernacular names are given for all species and some distinctive subspecies, *e.g.* Bewick's Swan *Cygnus columbianus bewickii*. These names follow the *Handbook of the Birds of the World* (del Hoyo *et al.* 1992, 1996), with the addition, in many cases, of alternative

names that are still in common usage over much of the species' range. When the English name in common usage in North America differs from that used in the Old World, both names are given. Alternative names are separated from the preferred name by a comma.

Subspecies and population

The subspecies and population column contains the name of the subspecies concerned and/or a brief geographical description to separate the population from other populations of the same subspecies (or other populations of a monotypic species). The primary source for treatment of species at subspecific level has been the *Handbook of the Birds of the World* (del Hoyo *et al.* 1992, 1996). However, the treatment of the grebes follows O'Donnell & Fjeldså 1995, and the herons follow Hafner *et al.* 2003 (see above). Some additional subspecies that are recognised by other sources but not listed in the *Handbook of the Birds of the World* have been included in brackets, as have newly recognised subspecies. Subspecies that are considered by most modern authorities to be invalid are omitted. Populations that have been identified primarily on the basis of their breeding ranges have been identified with the suffix (br); those identified primarily on the basis of their non-breeding ('wintering') ranges with the suffix (non-br).

Breeding range and non-breeding range

Two columns define the main breeding range and core non-breeding ('wintering' or 'contra-nuptial') range of every recognised population of a species or subspecies. Many migratory species, especially the long-distance migrants, sometimes stray far outside their normal ranges. The occurrence of these vagrants has not been taken into account in the range descriptions, which are intended to indicate where the great bulk of the population occurs during its normal annual cycle. In the case of sedentary species, a single entry in the Breeding range column describes the overall range of the population concerned.

It will be noticed that in many cases there is considerable similarity between the breeding ranges or non-breeding ranges of two or more populations of the same species. In some cases, this is because of a genuine overlap in the distribution of the populations. Thus, many populations defined on the basis of their breeding ranges are known to mix extensively with other populations of the same species in their non-breeding ('wintering') range, while many populations defined on the basis of their non-breeding ranges are known to overlap extensively with other populations on their breeding grounds. In many other cases, however, the main reason for an apparent similarity in ranges during the non-breeding season is uncertainty as to the limits of the non-breeding range of a particular population within the non-breeding range of the species or subspecies as a whole. In these cases, the non-breeding range is given only in very general terms, and will need refining as further information becomes available.

The larger geographical regions most commonly used to describe the ranges of populations in the range description columns are listed below alongside the range states that they usually encompass. This list does not attempt to conform to any other definitions of these regions, and the groupings of states have been defined with no purpose other than to describe the boundaries of waterbird populations. Furthermore, these groupings are intended only as a guideline to the countries in which the population in question may occur. Depending on the species concerned, a minority of countries might be excluded from each region, or one or more additional countries might be added. In many cases, the geographical division of populations is discussed more fully in the source references.

North Africa – Algeria, Egypt, Libyan Arab Jamahiriya, Morocco, Tunisia.

West Africa – Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo.

Eastern Africa – Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Somalia, Sudan, Uganda, United Republic of Tanzania.

North-east Africa – Djibouti, Egypt, Eritrea, Ethiopia, Somalia, Sudan.

Southern Africa – Angola, Botswana, Lesotho, Madagascar, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe.

Central Africa – Cameroon, Central African Republic, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome and Principe.

Sub-Saharan Africa – All African states excluding North Africa, as defined above.

Tropical Africa – Sub-Saharan Africa excluding Lesotho, Namibia, South Africa and Swaziland.

North-west Europe – Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, The Netherlands, Norway, Sweden, Switzerland, United Kingdom of Great Britain and Northern Ireland.

North-east Europe – The northern part of the Russian Federation west of the Urals.

Central Europe – Austria, Czech Republic, Estonia, Germany, Hungary, Latvia, Liechtenstein, Lithuania, Poland, the Russian Federation around the Gulf of Finland and Kaliningrad, Slovakia, Switzerland.

Eastern Europe – Belarus, the Russian Federation west of the Urals, Ukraine.

Western Siberia – The Russian Federation from the Urals to the Yenisey River and south to the Kazakhstan border.

Central Siberia – The Russian Federation from the Yenisey River to the Lena River and south to the Altai Mountains.

West Mediterranean – Algeria, France, Italy, Malta, Monaco, Morocco, Portugal, Spain, Tunisia.

East Mediterranean – Albania, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, Greece, Israel, Lebanon, Libyan Arab Jamahiriya, Montenegro, Serbia, Slovenia, Syrian Arab Republic, the former Yugoslav Republic of Macedonia, Turkey.

Black Sea – Armenia, Bulgaria, Georgia, Republic of Moldova, Romania, Russian Federation, Turkey, Ukraine.

Caspian – Azerbaijan, Islamic Republic of Iran, Kazakhstan, Russian Federation, Turkmenistan, Uzbekistan.

South-west Asia – Bahrain, Islamic Republic of Iran, Iraq, Israel, Jordan, Kazakhstan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, eastern Turkey, Turkmenistan, United Arab Emirates, Uzbekistan, Yemen.

Western Asia – The western part of the Russian Federation east of the Urals and the states bordering on the Caspian Sea.

Central Asia – Afghanistan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan.

South Asia – Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka.

Eastern Asia – China (Mainland and Taiwan Island), Democratic People's Republic of Korea, Japan, Mongolia, Republic of Korea, Russian Federation from the eastern edge of the Taimyr to the Sea of Okhotsk and the Bering Sea.

South-east Asia – Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, Vietnam.

Australasia – Australia, New Zealand, New Guinea and outlying islands, Solomon Islands.

Oceania – Australasia (as defined above) and Pacific island states and dependencies including Hawaii.

North America – Canada, Greenland, Mexico, United States of America.

Central America – Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama.

South America – All states of the South American continent, Falklands/Malvinas, Netherlands Antilles, Trinidad and Tobago.

Caribbean – Caribbean island states and dependencies (excluding Netherlands Antilles and Trinidad and Tobago).

NW South America – Bolivia, north-western Brazil, Colombia, Ecuador, Peru, Venezuela.

NE South America – North-eastern Brazil, French Guiana, Guyana, Suriname, Venezuela.

Southern South America – Argentina, southern Brazil, Chile, Paraguay, Uruguay.

Neotropics – South American states, Caribbean island states and dependencies, Central American states.

The division of species into populations should not be regarded as definitive. When a population is defined and an estimate given, we consider the population to be a valid unit for the species concerned. The consequences of this approach will be that populations might be split into smaller geographical units in future editions of *Waterbird Population Estimates*, but would be less likely to be merged into larger units.

Ramsar regions

Columns following the range description indicate the distribution of each species, subspecies or population within the six administrative regions of the Ramsar Convention. These regions are as follows: Africa, Europe, Asia, Oceania, Neotropics and North America. For the purposes of this publication, Asia is taken to include the Philippines and Indonesia east to, and including, the Lesser Sundas, and to extend west to include Asia Minor. Oceania, the Neotropics and North America are defined as in the preceding section.

Population size

Estimate

All estimates refer to the total number of individuals in the population, including immature birds, and are the most recent estimates available. In most cases, the estimates given in the tables are taken directly from the source references. However, all estimates have been rounded to a maximum of three significant figures, and rough estimates, particularly those given as a broad range, have been rounded to two significant figures.

Most population estimates included in this publication have been derived from censuses made towards the end of the non-breeding season or from estimations of breeding pairs. Waterbird populations tend to be at their lowest and most stable at these times. Individual numbers usually peak after the breeding season due to first year recruitment and suffer high and variable mortality over the non-breeding season making these times unsuitable for population estimation. To allow for the element of immature birds in each population, estimates given by original sources in the form of number of breeding pairs have been multiplied by three to give the total population size, as suggested by Meininger *et al.* (1995). Estimates given in the form of breeding adults or mature individuals (*i.e.* twice the number of breeding pairs) have been multiplied by a factor of 1.5. There is no intentional overlap between the populations of a species, and therefore all estimates for the populations of a species can be summed to produce a species total.

The population estimates are presented in one of four ways:

i. Blank indicates no information available or widely conflicting sources of data.

ii. Coded Ranges are used when only best-guess information is available rather than census data, or where census data or published information imply no greater accuracy than a coded range. The coded ranges are as follows:

A <10,000
B 10,000–25,000
C 25,000–100,000
D 100,000–1,000,000
E >1,000,000

iii. Numerical Ranges are given when stated in the source reference or to cover the variation implied by two similar estimates. In a few cases, numerical ranges have been replaced by coded ranges when the upper and lower limits are equal to or exceed the coded ranges given above.

iv. Precise Estimates are given if stated in the source.

When two widely differing estimates exist for the same population and it is unclear which is the more reliable, either no estimate has been given, or the maximum and minimum of the two estimates have been combined to give a broad range.

These four ways of presenting estimates give a good idea of the quality of data available as the basis of each estimate. The first two editions of *Waterbird Population Estimates* included a column headed 'Type' in which data quality was assessed and presented as one of three codes. This system was dropped from the third and current editions until resources are available to include something more useful.

Source

The source reference for population estimates is coded by an alphanumeric code corresponding to the codes given to the left of the references listed in the References section at the end of the book. In cases where numerous sources have been used to calculate the estimate, all sources are given, and explanation is provided in the Notes column.

Population status

Trend

As an additional indication of the conservation status of each population, an indication of the recent trend in the population is given. This is expressed very simply by one of the following five categories:

STA Stable
DEC Decreasing
INC Increasing
FLU Fluctuating
EXT Extinct

Uncertainty is expressed with a question mark, or by use of two categories separated by a slash, e.g., STA/DEC. A blank in the column indicates that no definitive recent information is available.

It has not been possible to standardise the time base for the trend. Instead, the trend stated in the source has been used regardless of the time base. The most recent trend has been chosen if more than one is available. There are also no recommended standards regarding the magnitude of change necessary before a population trend can be stated as increasing or decreasing. An effort will be made in future editions to standardise the assessment of trends as far as possible, but this will always be problematic because of the differences in the ecology of the species being considered, and the inherent effect this variation has on the most sensible time-base for assessing population trends. Generation length will in future be an important parameter to include in the time-basis for assessing population trends.

Source

The source reference for trends is coded by an alphanumeric code corresponding to the codes given to the left of references in the References section at the end of the book.

One percent thresholds for use in Ramsar Convention Criterion 6

The "1% level" column gives the 1% thresholds to be used in the application of the Ramsar Convention Criterion 6. For virtually all estimates given as a single figure or numerical range, the 1% threshold is equal to 1% of the estimate or 1% of the mid-point of the range. 1% thresholds have been rounded according to the following standard:

1% thresholds between 1 and 10	:	rounded to nearest 1
1% thresholds between 11 and 100	:	rounded to nearest 5
1% thresholds between 101 and 1,000	:	rounded to nearest 10
1% thresholds over 1,000	:	rounded to nearest 100

In a very few cases, the 1% threshold presented in the tables differs from the calculated value, reflecting an expert judgement that the most recent population estimate may no longer be valid. In all such cases, the discrepancy is explained in the Notes column. For all populations of 2,000,000 or more individuals, the 1% threshold is set at 20,000, as all sites which regularly hold 20,000 or more waterbirds of any species qualify as wetlands of international importance under Ramsar Criterion 5.

In the first two editions of *Waterfowl Population Estimates*, no attempt was made to set 1% thresholds on the basis of estimates given in the form of a coded range. Certainly, a 1% threshold set on the basis of the mid-point of such broad and poorly known ranges

would be unsafe. For example, a 1% threshold based on the mid-point of a range D estimate (100,000–1,000,000) could be as much as 45% below the true value. However, a 1% threshold based on the top end of a coded range would constitute a maximum value, and would be safe to use in the identification of wetlands of international importance. While such a provisional 1% threshold might be expected to change as better information becomes available, it would only be likely to come down. The provisional 1% thresholds set on the basis of coded ranges are as follows:

A (<10,000)	:	1% threshold	100
B (10,000–25,000)	:		250
C (25,000–100,000)	:		1,000
D (100,000–1,000,000)	:		10,000
A/B (<25,000)	:		250
B/C (10,000–100,000)	:		1,000

No 1% thresholds have been set on the basis of coded ranges C/D (25,000–1,000,000), D/E (100,000–>1,000,000) or E (>1,000,000) because of the considerable uncertainty in these estimates. Obviously, however, the maximum 1% threshold of 20,000 could be applied to all populations with estimates of this type, and indeed to all those populations for which no estimate is available.

Notes

The final column in the tables contains a variety of short notes to explain possible sources of confusion and to provide additional information on taxonomy. The two symbol alphanumeric codes which appear in the notes column are the same as those used in the "source" columns, and correspond to the codes used to identify references and sources at the end of the book. In many cases, this column has been used to explain the derivation of a population estimate when the estimate given in the tables differs in form from that in the source reference (*i.e.* is given as individuals in the table rather than as breeding pairs or mature adults in the source reference), or when the estimate has been derived from a combination of information from two or more sources. This column has also been used to draw attention to those 1% thresholds set at 20,000 for populations with more than 2,000,000 individuals, *i.e.* those populations to which Ramsar Criterion 5 applies.

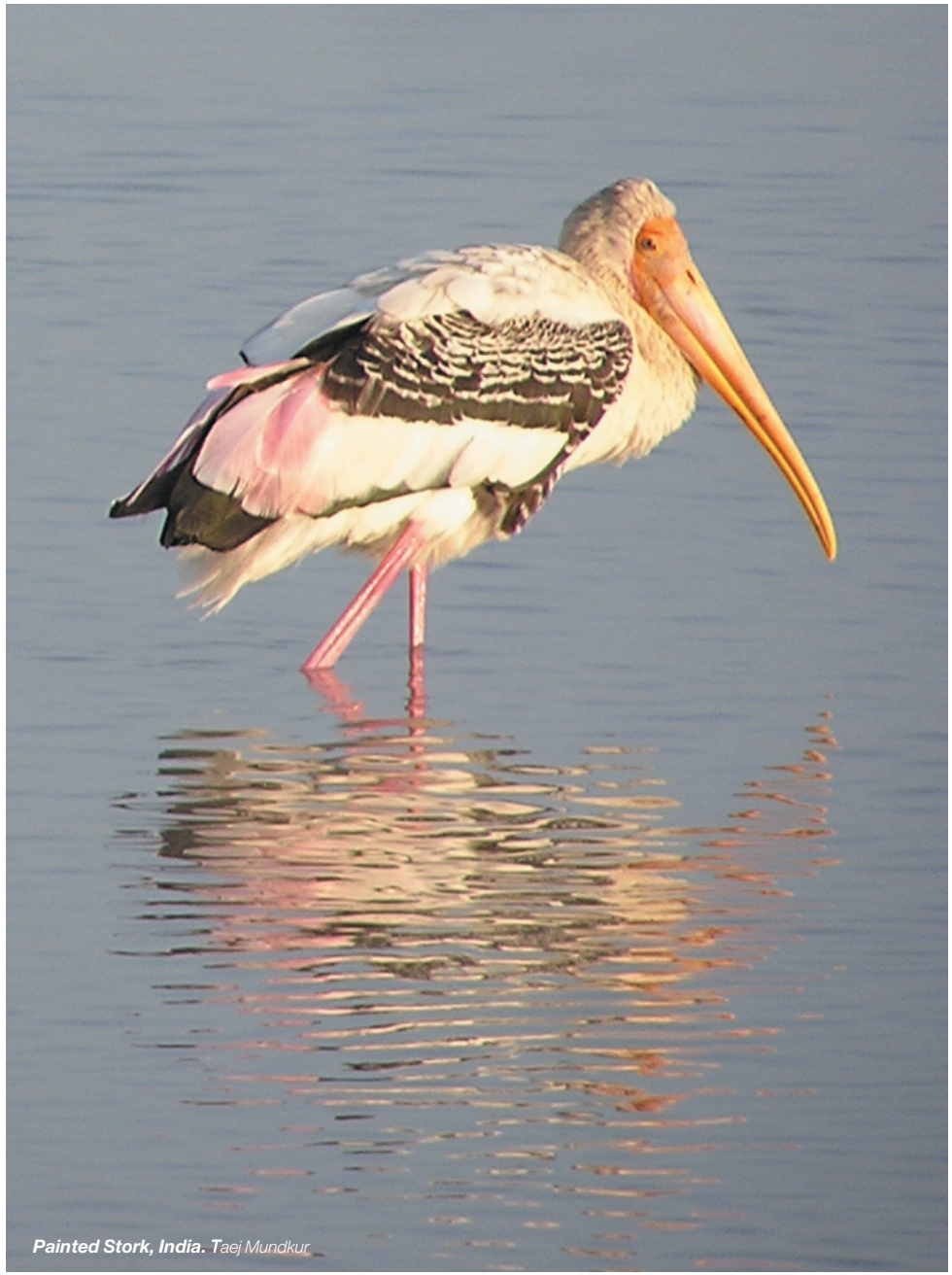
Globally threatened and near-threatened species

All globally threatened species, as listed in *Threatened Birds of the World* (BirdLife International 2000) and updated in 2006 (http://www.birdlife.org/datazone/species/index.html), are highlighted by the use of a red header in the table and all near-threatened species by the use of orange. Obviously, all populations of a globally threatened (or near-threatened) species are themselves globally threatened (or near-threatened). However, if globally-threatened status were to be assessed at subspecies or even population level, many more populations would be identified as being at risk. It has not as yet been possible to apply such an assessment to all the subspecies, or the 2,305 populations of waterbirds now included in *Waterbird Population Estimates*, but it is hoped that this can be addressed in future.

Abbreviations used in the tables

Abbreviations used in the range descriptions in Columns 3, 4 and 5 include the following:

AfWC	African Waterbird Census
AWC	Asian Waterbird Census
BBS	Breeding Bird Survey
br	Breeding
C	Central
CWS	Canadian Wildlife Service
E	Eastern
IBA	Important Bird Area
IWC	International Waterbird Census
Is	Island(s)
N	Northern
NE	North-eastern
NW	North-western
NWC	Neotropical Waterbird Census
non-br	Non-breeding
S	Southern
SE	South-eastern
SW	South-western
UK	United Kingdom
USA	United States of America
USFWS	United States Fish & Wildlife Service
W	Western



Painted Stork, India. *Taej Mundkur*

Discussion and conclusions

Number of species and populations

This edition summarises waterbird populations of 878 species, compared with 868 in the third edition (2002), 840 in the second edition (1997) and 833 in the first edition (1994). Reasons for this fourth increase in the number of species considered are the inclusion of a small number of recent taxonomic splits, the discovery or recognition of seven additional species considered to have become extinct since the year 1600, and discovery of one entirely new species, Calayan Rail, *Gallirallus calayensis* in 2004. A total of 2,305 biogeographic populations are now recognised, compared with 2,271 in the third edition, 1,924 in the second edition and 1,824 in the first. The increase in the present edition is largely due to further sub-divisions of some populations on the basis of improved knowledge. Changes in the species and populations listed in this edition compared with the previous editions are summarised in Table 1, and listed in full in Table 2.

Population estimates are presented for 1,816 of the 2,305 populations, a total of 79%. Population trends are presented for 1,200 of the 2,305 populations, a total of 52%. Table 1 compares these totals with the three earlier editions of Waterbird Population Estimates. The table does not show is the improvement in the quality of data. Very many of the estimates and trends were updated with better ones in 2005.

Table 1. The growth in knowledge of the world's waterbird numbers and population trends over twelve years, as represented by the content of Wetlands International's *Waterbird Population Estimates* series

	WPE1, 1994	WPE2, 1997	WPE3, 2002	WPE4, 2006
No of species	833	840	868	878
No of biogeographic populations	1,824	1,924	2,271	2,305
No of population estimates	1,186	1,342	1,725	1,816
% pops with estimates	65%	70%	76%	79%
No of population trends	727	792	1,138	1,200
% pops with trends	40%	41%	50%	52%

Table 2. Changes in species and populations included in WPE4 (2006) compared with WPE3 (2002)

Species	Change at species level since WPE3
***Phalacrocorax atriceps*, Imperial Shag, Blue-eyed Shag**	*bransfieldensis, georgianus, melanogenis, verrucosus, nivalis* & *purpurascens* all formerly considered to be separate species
***Ixobrychus minutus*, Little Bittern**	The extinct *novaezelandiae* now considered to be a separate species, ***Ixobrychus novaezelandiae*, New Zealand Little Bittern**
***Threskiornis aethiopicus*, Sacred Ibis**	*bernieri* and *abbotti* split to form new species, ***Threskiornis bernieri*, Madagascar Sacred Ibis**
***Bostrychia olivacea*, Olive Ibis**	*bocagei* split to form new species, ***Bostrychia bocagei*, Dwarf Olive Ibis**
***Phoenicopterus ruber*, Greater Flamingo** (see also population changes below)	*ruber* split to form new species, ***Phoenicopterus ruber*, Caribbean Flamingo.** Greater Flamingo now named ***Phoenicopterus roseus***
***Alopochen kervazoi*, Réunion Island Sheldgoose**	Extinct species not previously listed
***Anas (crecca) carolinensis*, Green-winged Teal**	Now listed as a sub-species of *Anas crecca*
***Gallirallus calayensis*, Calayan Rail**	Species discovered in 2004
***Dryolimnas augusti*, Réunion Rail**	Extinct species not formerly listed
***Porzana astrictocarpus*, St Helena Rail**	Extinct species not formerly listed
***Diaphorapteryx hawkinsi*, Hawkins' Rail**	Extinct species not formerly listed
***Porphyrio kukwiedei*, New Caledonia Gallinule**	Extinct species not formerly listed
***Porphyrio mantelli*, North Island Takahe**	Extinct species not formerly listed
***Gallinula nesiotis*, Tristan Moorhen**	*comeri* now listed as separate species, ***Gallinula comeri*, Gough Moorhen**
***Rostratula benghalensis*, Greater Painted-Snipe**	split to form new species, ***Rostratula australis*, Australian Painted Snipe**
***Cursorius cursor*, Cream-coloured Courser**	*somalensis* and *littoralis* now split into separate species, ***Cursorius somalensis*, Somali Courser**
***Scolopax saturata*, Dusky Woodcock, Rufous Woodcock**	Now split into two species: ***Scolopax saturata*, Javan Woodcock** and ***Scolopax rosenbergi*, New Guinea Woodcock**

Species	Change at population level since WPE3
***Phalacrocorax nigrogularis*, Socotra Cormorant**	Now split into two populations, breeding on the Arabian coast and in the Gulf of Aden, respectively
***Ardea (Bulbucus) ibis*, Cattle Egret**	The Falkland/Malvinas Islands population is now considered invalid. Annual visitors never survive
***Butorides striata*, Striated Heron**	Separate population in Bolivia considered invalid
***Mycteria ibis*, Yellow-billed Stork**	Separate population in Madagascar now recognised
***Jabiru mycteria*, Jabiru**	Central America and Northern South America populations merged
***Bostrychia rara*, Spot-breasted Ibis**	Central African and West African populations now considered to be separate
***Platalea alba*, African Spoonbill**	Separate population in Madagascar now recognised
***Phoenicopterus roseus*, Greater Flamingo**	See also species changes above. East Mediterranean, and South and Southwest Asia populations now considered to be separate. Extinct population on Réunion and Mauritius now listed

Species	Change at population level since WPE3
***Cygnus atratus*, Black Swan**	Separate population in Tasmania now merged with mainland Australian population
***Anser fabalis*, Bean Goose**	*johanseni* no longer considered valid. Separate population of *fabalis* now considered to winter in Central Asia
***Chloephaga poliocephala*, Ashy-headed Goose**	Separate population in Falkland/Malvinas Islands now considered invalid
***Malacorhynchus membranaceus*, Pink-eared Duck**	Separate populations in SW and SE Australia now merged
***Histrionicus histrionicus*, Harlequin (Duck)**	North American and Greenland wintering populations now considered to be separate
***Melanitta perspicillata*, Surf Scoter**	Populations wintering on east and west coasts of North America now considered to be separate
***Mergus serrator*, Red-breasted Merganser**	Populations wintering on east and west coasts of North America now considered to be separate
***Mergus merganser*, Goosander, Common Merganser**	UK population now merged with that of continental NW & Central Europe. Population of eastern and central North America now separated from that of western North America
***Grus canadensis*, Sandhill Crane**	*rowani* now considered to be invalid
***Canirallus oculeus*, Grey-throated Rail**	Populations of the Congo Basin and west Central Africa now considered to be separate
***Dryolimnas cuvieri*, White-throated Rail**	Extinct population in Mauritius not formerly listed
***Porphyrio porphyrio*, Purple Swamphen**	*madagascariensis* now sub-divided into four populations. *melanotus* sub-divided into separate populations in Australia and New Zealand
***Gallinula tenebrosa*, Dusky Moorhen**	*tenebrosa* now divided into two populations, occurring in East & Central, and Southwest Australia
***Fulica cristata*, Red-knobbed Coot**	Separate population now recognised in Madagascar
***Himantopus leucocephalus*, Australian Black-winged Stilt**	New Zealand population now separated from that of Australia & SE Asia
***Cursorius temminckii*, Temminck's Courser**	Additional population, *ruvanensis,* now recognised
***Vanellus crassirostris*, Long-toed Lapwing**	Additional population of *crassirostris* now recognised in coastal Angola
***Charadrius pecuarius*, Kittlitz's Plover**	*tephricolor* no longer considered to be valid
***Scolopax rusticola*, Eurasian Woodcock**	Resident populations of Azores, Madeira and Canary Islands each now considered to be separate
***Calidris maritima*, Purple Sandpiper**	West Greenland resident population now considered to be separate
***Larus fuscus*, Lesser Black-backed Gull**	*intermedius* now recognised as separate population
***Larus cirrocephalus*, Grey-headed Gull**	*poiocephalus* in central, eastern and southern Africa now separated into two populations
***Larus minutus*, Little Gull**	Population in East China now considered to be invalid
***Sterna nilotica*, Gull-billed Tern**	An additional population, *affinis*, is recognised in SE Asia-Australia
***Sterna caspia*, Caspian Tern**	(*strenua*) has been divided into separate populations in Australia and New Zealand
***Sterna vittata*, Antarctic Tern**	An additional population, *sanctipauli*, is recognised

Summary of population estimates by Ramsar region

Table 3 summarises waterbird population sizes in each of the world's six Ramsar regions. Figure 1 presents this information in frequency distribution graphs, and equivalent population size distributions presented in the third edition (Wetlands International 2002) are also shown for comparison. The information is also presented in Table 3.

Table 3 shows that the largest number of waterbird populations (815) is found in Asia, followed by the Neotropics (554) and Africa (542). Fewer waterbird populations are found in Oceania (390), North America (384) and Europe (351). These totals reflect the biogeography of the regions, with the tropics supporting greater biodiversity, and also the land area of the different regions, with Oceania, despite its extension into the tropics, having a disproportionately small land area, and a relatively small extent of permanent wetlands.

The best-known populations occur in Europe, where estimates are now available for 97% of populations, and Africa (92%). These are followed by Asia (84%), North America (84%), Oceania (75%) and the Neotropics (61%). The high proportion of populations in Africa for which estimates are now available reflects the attention given to waterbirds on the continent by Wetlands International and BirdLife International since the 1990s, with a publication in preparation since 2002 providing a detailed summary of the state of knowledge of every waterbird population in Africa (Dodman, in review). It should be borne in mind that the quality of estimates in the different regions is just as variable as their quantity, and in Africa, for example, a relatively high proportion of the new estimates are imprecise, covering broad ranges. Such estimates provide a valuable starting point in the population estimation process. Work stimulated by the African-Eurasian Migratory Waterbird Agreement (AEWA) will ensure an increasingly sound basis for the conservation of waterbird populations in this region. The Asia-Pacific Migratory Waterbird Conservation Strategy (e.g. Asia-Pacific Migratory Waterbird Conservation Committee, 2001) and the Central Asian Flyway Initiative (see http://www.cms.int/news/PRESS/nwPR2006/nw013206_CAF_AP.htm) are covering similar ground, and it is to be hoped that a comparable approach can be adopted in the New World to improve the conservation of waterbirds in the region where they are least well known of all: the Neotropics.

The graphs in Figure 1 illustrate the state of knowledge in the different regions described above, and compare the findings of this fourth edition of Waterbird Population Estimates with the third edition published in 2002. The most noteworthy improvement in the state of knowledge revealed by this figure is a 9% increase in the number of population estimates available for Oceania, and a 5% increase for Asia. These improvements reflect a special effort to compile waterbird survey data from Australia by the Brisbane Office of Wetlands International, and the continuing growth and effectiveness of the Asian Waterbird Census, coordinated out of Wetlands international's office in Kuala Lumpur. The number of available waterbird populations in North America, and especially Europe and Africa is now very high There was an increase in 2% in estimates available from the Neotropical region, but, the number of known populations in this part of the world (61%) is still considerably fewer than any of the other Ramsar regions.

The frequency of occurrence of populations of different size ranges in every region shows small numbers of populations in the low and high categories (ranges 10,001–25,000, and >1,000,000) and relatively high numbers of populations in the intervening categories (25,001–100,000 and 100,001–1,000,000). The exception to this distribution is that in all regions except Europe, a disproportionately high proportion of populations fall in the lowest range (<10,001). This is partly explained by the fact that the small populations have the highest priority for conservation action. The small populations are therefore usually the best known populations, and the summary of knowledge of all the world's threatened bird species in one publication (BirdLife International 2000) has allowed ready access to this information. The particularly high proportion of small populations in the tropical regions, which have the highest overall biodiversity, is to be expected, as is the highest proportion of all in Oceania, with its many specialised island forms.

Table 3. Waterbird population sizes in the six Ramsar regions (the "%" columns give percentage of populations of known size).

Ramsar region	Number of populations lacking estimate		Number of populations in each size category										Total of populations with known size		Total number of populations
			<10,001		10,001–25,000		25,001–100,000		100,001–1,000,000		>1,000,000				
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Africa	41	8	164	33	77	15	121	24	120	24	19	4	501	92	542
Europe	11	3	35	10	34	10	98	29	130	38	43	13	340	97	351
Asia	129	16	132	19	68	10	218	32	208	30	60	9	686	84	815
Oceania	99	25	132	45	34	12	51	18	56	19	18	6	291	75	390
Neotropics	214	39	92	27	43	13	76	23	82	24	45	13	340	61	554
North America	61	16	46	14	35	11	62	19	134	41	46	14	323	84	384
Global Total	**489**	**21**	**550**	**30**	**225**	**12**	**446**	**25**	**470**	**26**	**125**	**7**	**1,816**	**79**	**2,305**

Global totals do not equal the sum of the respective columns because populations are often distributed in more than one Ramsar region.

Figure 1. Waterbird population sizes in the six Ramsar regions: the percentage of populations in each of six numerical ranges in each Ramsar region. WPE3 (2002) and WPE4 (2006) compared.

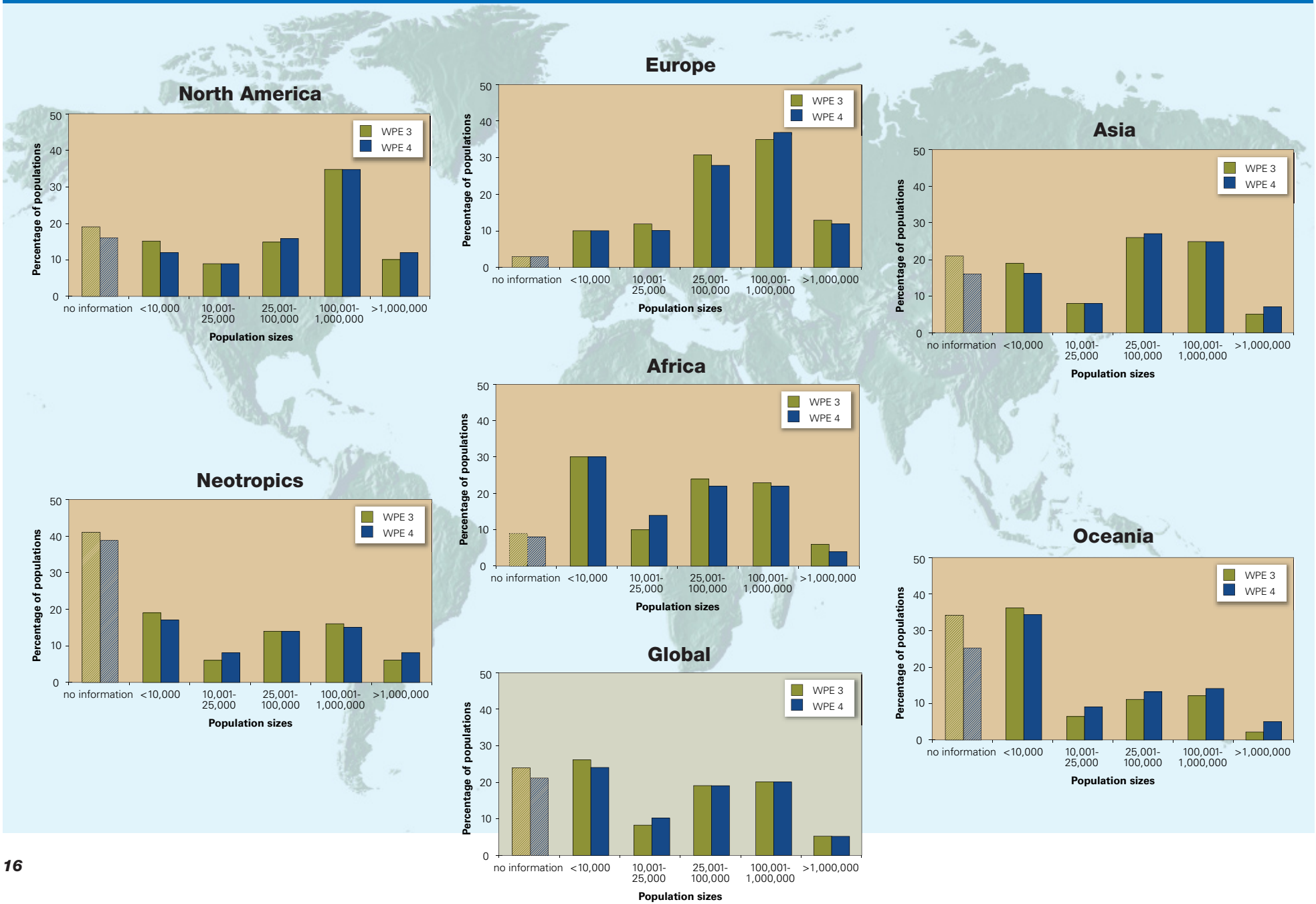
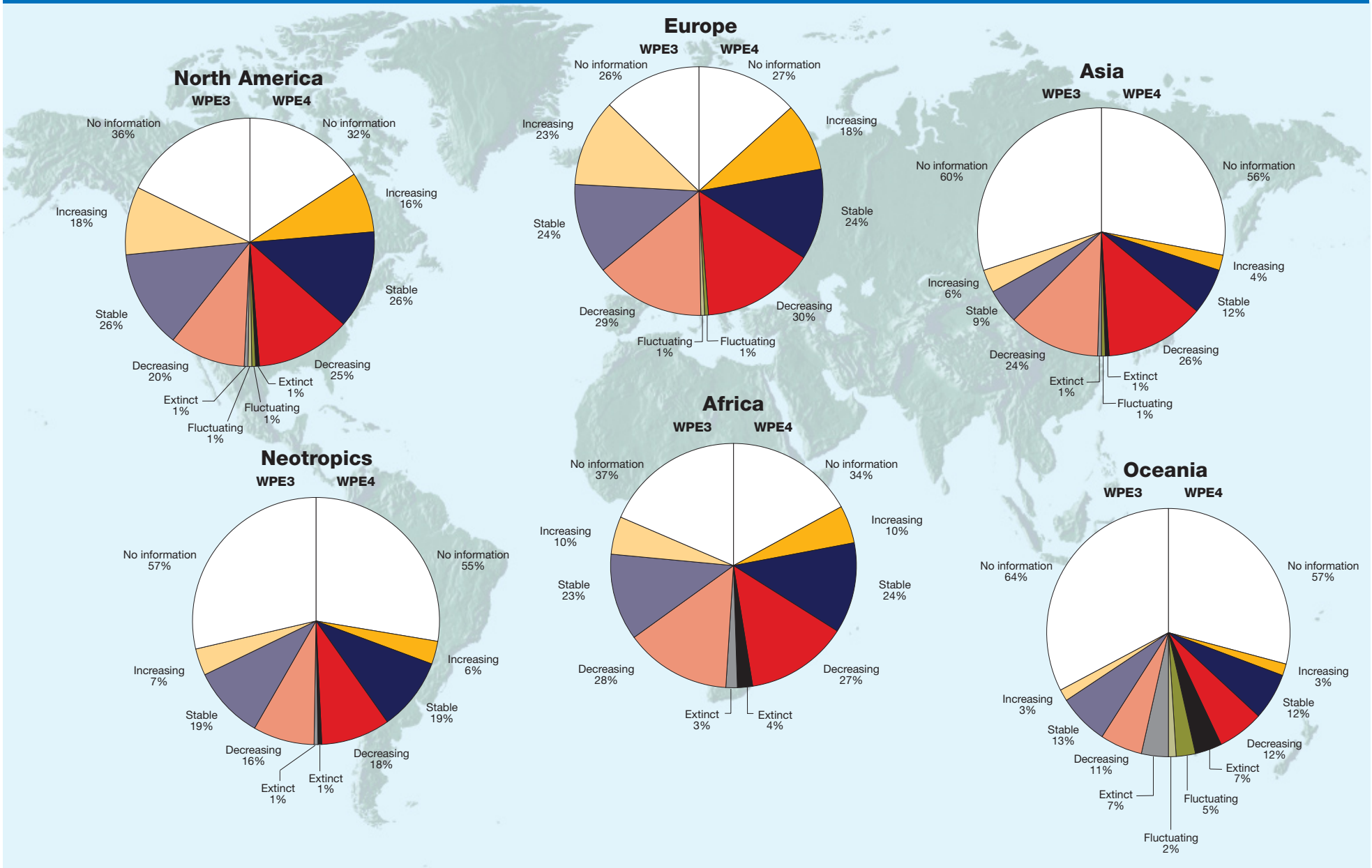


Figure 2. Waterbird population trends in the six Ramsar regions: the percentage of populations showing each of six population trend tendencies in each Ramsar region. WPE3 (2002) and WPE4 (2006) compared.



Summary of population trends by Ramsar region

Table 4 and Figures 2 and 3 summarise the estimated population trends in each Ramsar region. Trends expressed in the WPE tables as unconventional codes such as STA/DEC, or EXT? have been included in the tables and graphs in simplified form, e,g. STA, or EXT.

Table 4 shows that the highest proportion of waterbird population trends has been estimated in Europe (257, 73% of those in the region), followed by North America (261, 68%) and Africa (357, 66%). A smaller proportion of waterbird population trends have been estimated in the Neotropics (247, 45%), Asia, (358, 44%) and Oceania (167, 43%). The relatively high proportion of populations lacking trend information means that conclusions should be treated with caution. In particular, bias is introduced into the discussion by the fact that, as detailed above, more is often known about small populations than large ones, and these small populations are perhaps more likely to be in decline.

At global level, the fact that 40% of known populations are declining, 34% are stable and only 17% increasing (Table 4) gives considerable cause for concern and highlights the need for an increase in efforts to conserve these species and their habitats.

Figure 2 is a summary on pie charts of the proportion of waterbird populations in each of the world's six Ramsar regions exhibiting the following population trends: Increasing, Stable, Decreasing, Extinct, and Fluctuating. The (relatively high) proportion of populations for which this population trend information is lacking is also shown. Figure 2 also compares the proportion of populations in each region in each category presented in 2002 in WPE3 with the situation in 2006.

Changes in the proportions of increasing and decreasing trends since the publication of WPE3 in 2002, although small, have nearly all been unfavourable (Figure 2). Overall, the number of increasing populations was 1% lower at 9%, and the number of decreasing populations 1% higher at 21% in 2006 than in 2002. When populations for which no trend data are available are removed from calculations, the number of increasing populations was 2% lower, at 17%, while the number of decreasing populations was almost identical, but rounding conventions put the proportion down 1% to 40%. The actual change was from 40.51% in 2002 to 40.42% in 2006. The proportion of populations with increasing trends was lower in 2006 than in 2002 in four Ramsar regions (Europe, Asia, Neotropics and North America) and unchanged in two (Oceania and Africa). The proportion of populations with decreasing trends was higher in 2006 than in 2002 in every Ramsar region except Africa.

It is clear from Figures 2 and 3 that in every region, the proportion of known populations exhibiting a decreasing trend markedly exceed the proportion exhibiting an increasing trend. In Europe and North America, where data quality are best and where waterbird conservation policy is most advanced, the proportion of decreasing populations is over one and a half times higher than the proportion which is increasing. The number of decreasing populations exceeds the number increasing by two and a half times in Africa, over three and a half times in the Neotropoics, four times in Oceania, and almost six times in Asia.

Figure 3 illustrates the proportion of waterbird populations for which trends are available which are

Figure 3. Percentage of known waterbird populations in each Ramsar region showing each of five population trends.

The baseline has been set at the midpoint of the two neutral trend categories (Stable and Fluctuating). The position of each bar therefore reflects the proportion of populations in the region which is increasing, and the proportion which is Decreasing/Extinct.

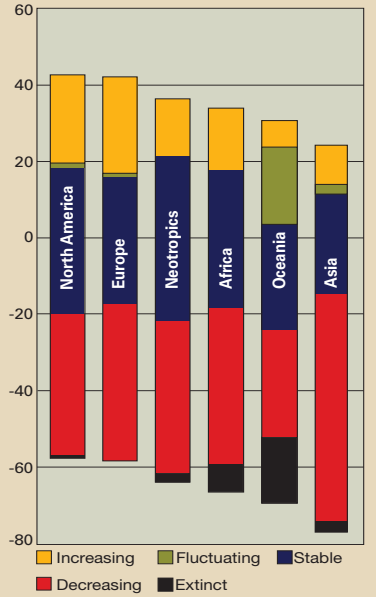


Table 4. Waterbird population trends in the six Ramsar regions (the "%" columns give percentage of populations with known trend).

Ramsar region	Number of populations with lacking trend		Number of populations in each trend category												Total of populations with known trend		Total number of populations
			Increasing		Stable		Decreasing		Extinct		Extinct?		Fluctuating				
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Africa	185	34	56	16	130	36	146	41	20	6	4	1	1	0	357	66	542
Europe	94	27	63	25	85	33	106	41	0	0	0	0	3	1	257	73	351
Asia	457	56	36	10	98	27	210	59	2	1	6	2	6	2	358	44	815
Oceania	223	57	11	7	47	28	46	28	24	14	5	3	34	20	167	43	390
Neotropics	307	55	36	15	105	43	99	40	5	2	1	0	1	0	247	45	554
North America	123	32	60	23	100	38	97	37	1	0	1	0	2	1	261	68	384
Global Total	**1,105**	**48**	**198**	**17**	**410**	**34**	**485**	**40**	**52**	**4**	**16**	**1**	**39**	**3**	**1,200**	**52**	**2,305**

Global totals do not equal the sum of the respective columns because a population is often distributed in more than one Ramsar region.

extinct, decreasing, stable, fluctuating or increasing in each Ramsar region. The baseline of this graph has been set at the midpoint of the two neutral trend categories, Stable and Fluctuating. The overall position relative to the y axis of the bar representing each Ramsar region therefore indicates the overall conservation status of waterbird populations for which information is available in that Ramsar region. Only 7% of populations with known trends in Oceania and 10% in Asia, now have increasing populations. The region where the highest proportion of known populations are decreasing is Asia (59%), followed by three regions where 40% or 41% of populations are decreasing: Africa, the Neotropics and Europe. It is of great concern that Asia, which has the highest number of waterbird populations of any Ramsar region, also has by far the highest number of decreasing populations, and the second-lowest number which are increasing. In Oceania, the apparently relatively low number of decreasing populations (28%) should be put in the context of the fact that 17% of known waterbird populations in this region are already extinct or probably extinct, largely because of the effects of human pressure on specialised island forms in recent centuries. Furthermore, the proportion of known populations in this region identified as showing a fluctuating trend increased markedly from 4% in 2002 to 20% in 2006, thanks to a thorough review of populations in Australia, where the enormous extent of ephemeral wetlands favours waterbird species which can adapt their life cycles to periodic, highly productive breeding attempts which correspond to the extremely variable availability of suitable wetland habitat.

Summary of population estimates by family

Table 5 gives a summary of the frequency distribution of population size categories in each of the world's 33 waterbird families.

More than half of the families of waterbirds now have well-known populations, for which 90% or more of populations have size estimates. These are as follows: Gaviidae, Podicipedidae, Phalacrocoracidae, Scopidae, Ciconiidae, Balaenicipitidae, Threskiornithidae, Phoenicopteridae, Anhimidae, Anatidae, Gruidae, Dromadidae, Haematopodidae, Recurvirostridae, Charadriidae, Pedionomidae and Laridae. Four of these families, Gaviidae, Phalacrocoracidae, Theskiornithidae and Charadriidae, passed the 90% threshold between publication of WPE3 in 2002 and this edition in 2006.

Relatively poorly-known families, for which two-thirds or fewer of populations have population size estimates are as follows: Aramidae, Rallidae, Eurypigidae, Jacanidae, Ibidorhynchidae, Burhinidae and Thinocoridae. With the exception of Rallidae, these are all relatively small families, but the Rallidae, with 365 populations is one of the largest families, with population estimates being available for only 150 of these populations (41%). Two families, Anhingidae and Rostratulidae, were included in this group in 2002, but have since exceeded the two-thirds threshold.

Families with a high proportion (half or more) of estimated populations which are known to be small (10,000 or fewer) are as follows: Anhingidae, Ciconiidae, Balaenicipitidae, Gruidae, Rallidae and Pedionomidae. Five additional families were included in this group in 2002: Threskiornithidae , Heliornithidae, Rostratulidae, Haematopodidae, and Rynchopidae. This is a clear indication of the tendency for population estimates to increase as the state of knowledge improves

Summary of population trends by family

Table 6 gives a summary of the number and proportion of populations in each of the world's 33 waterbird families which are estimated to have Increasing, Stable, Decreasing or Fluctuating population trends, and the number of species in each family which are known to have become extinct since 1600, or which are probably extinct.

Relatively well-known families, for which more than 70% of populations have population trend estimates available, are as follows: Phalacrocoracidae, Pelecanidae, Anhingidae, Ciconiidae, Balaenicipitidae, Phoenicopteridae, Anhimidae, Anatidae, Gruidae, Dromadidae, Pedionomidae and Rynchopidae. One family, Phalacrocoracidae, has passed the 70% threshold and been added to this group since 2002.

Relatively poorly known families, for which one third or fewer of populations have population trend estimates available, are as follows: Scopidae, Aramidae, Heliornithidae, Eurypigidae, Jacanidae, Rostratulidae, Ibidorhynchidae, Burhinidae, Glareolidae, and Thinocoridae. There was one additional family in this category in 2002, Sternidae.

Nine out of the 33 families include populations of species which have become extinct since 1600; in order of the proportion of species in the family which have become extinct, these are: Rallidae, Haematopodidae, Podicipedidae, Ardeidae, Scolopacidae, Anatidae, Threskiornithidae, and Phalacrocoracidae. Two further families, Gruidae and Charadriidae, include populations which are probably extinct but for which definitive recent information is lacking.

Families with a high proportion (half or more) of estimated populations showing a decreasing trend are as follows: Anhingidae, Ciconiidae, Balaenicipitidae, Anhimidae, Rallidae, Heliornithidae, Jacanidae, Rostratulidae, Burhinidae, Charadriidae, Pedionomidae and Rynchopidae.

Changes in conservation status of Globally Threatened waterbird species between 2002 and 2006

Table 7 summarises differences in Red List status of waterbird species as listed in WPE3 and WPE4.

The threat status codes of species for which concern increased between 2002 and 2006 appear in red, and codes of those for which concern decreased appear in green.

Table 5. Waterbird population sizes by family (the "%" columns give percentage of populations of known size).

	Number of populations lacking estimate		Number of populations in each size category										Total of populations with known size		Total number of populations
			<10,001		10,001–25,000		25,001–100,000		100,001–1,000,000		>1,000,000				
Family	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Gaviidae	1	8	3	25	2	17	3	25	4	33	0	0	12	92	13
Podicipedidae	6	8	32	48	11	16	11	16	13	18	1	1	67	92	73
Pelecanidae	3	15	6	35	1	6	5	29	5	28	0	0	17	85	20
Phalacrocoracidae	7	9	20	28	9	13	18	25	21	30	3	4	71	91	78
Anhingidae	2	22	4	57	1	14	2	29	0	0	0	0	7	78	9
Ardeidae	93	36	55	33	17	10	40	24	48	29	6	4	166	64	259
Scopidae	0	0	0	0	1	33	1	33	1	33	0	0	3	100	3
Ciconiidae	2	5	19	51	5	14	8	22	5	14	0	0	37	95	39
Balaenicipitidae	0	0	1	100	0	0	0	0	0	0	0	0	1	100	1
Threskiornithidae	5	7	29	45	6	14	14	22	9	14	3	5	64	93	69
Phoenicopteridae	0	0	3	16	1	5	6	47	5	26	1	5	19	100	19
Anhimidae	0	0	1	33	0	0	1	33	1	33	0	0	3	100	3
Anatidae	12	3	111	24	51	11	107	23	148	32	39	9	456	97	468
Gruidae	2	4	31	66	3	6	11	23	2	4	0	0	47	96	49
Aramidae	3	75	0	0	0	0	0	0	0	0	1	100	1	25	4
Rallidae	215	59	92	61	14	9	12	8	16	11	16	11	150	41	365
Heliornithidae	1	14	2	33	1	17	2	33	1	17	0	0	6	86	7
Eurypygidae	3	100	0	0	0	0	0	0	0	0	0	0	0	0	3
Jacanidae	11	65	1	17	0	0	2	33	2	33	1	17	6	35	17
Rostratulidae	1	25	1	33	1	33	0	0	1	33	0	0	3	75	4
Dromadidae	0	0	0	0	0	0	1	100	0	0	0	0	1	100	1
Haematopodidae	1	5	9	45	4	20	4	20	2	10	1	5	20	95	21
Ibidorhynchidae	1	100	0	0	0	0	0	0	0	0	0	0	0	0	1
Recurvirostridae	1	4	3	12	3	12	11	44	8	32	0	0	25	96	26
Burhinidae	10	40	3	20	7	47	4	27	1	7	0	0	15	60	25
Glareolidae	13	28	6	18	8	24	12	35	7	21	1	3	34	72	47
Charadriidae	16	10	39	28	24	17	46	33	28	20	4	3	141	90	157
Scolopacidae	26	12	26	13	15	8	65	33	72	36	21	11	199	88	225
Pedionomidae	0	0	1	100	0	0	0	0	0	0	0	0	1	100	1
Thinocoridae	7	70	0	0	2	57	0	0	1	33	0	0	3	30	10
Laridae	8	8	13	13	6	6	23	24	39	40	16	16	97	92	105
Sternidae	38	22	37	27	27	20	33	24	30	22	11	8	138	78	176
Rynchopidae	1	14	2	33	2	33	1	17	1	17	0	0	6	86	7
Global Total	**489**	**21**	**550**	**30**	**225**	**12**	**445**	**25**	**470**	**26**	**125**	**7**	**1,816**	**79**	**2,305**

Table 6. Waterbird population trends by family (the "%" columns give percentage of populations with known trend).

	Number of populations lacking trend		Number of populations in each trend category												Total of populations with known trend		Total number of populations
			Increasing		Stable		Decreasing		Extinct		Extinct?		Fluctuating				
Family	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Gaviidae	8	62	0	0	3	60	2	40	0	0	0	0	0	0	6	38	13
Podicipedidae	36	49	5	14	12	32	16	43	2	5	1	3	1	3	37	51	73
Pelecanidae	4	20	7	44	3	19	5	31	0	0	0	0	1	6	16	80	20
Phalacrocoracidae	34	44	11	25	22	50	9	20	1	2	0	0	1	2	44	56	78
Anhingidae	1	11	0	0	2	25	5	63	0	0	0	0	1	13	8	89	9
Ardeidae	153	59	20	19	44	42	35	33	4	4	0	0	3	3	100	41	259
Scopidae	2	67	0	0	1	100	0	0	0	0	0	0	0	0	1	33	3
Ciconiidae	9	23	4	13	7	23	19	63	0	0	0	0	0	0	30	77	39
Balaenicipitidae	0	0	0	0	0	0	1	100	0	0	0	0	0	0	1	100	1
Threskiornithidae	23	33	4	9	16	35	20	43	1	2	1	2	4	9	48	67	69
Phoenicopteridae	3	16	5	31	8	50	2	13	1	6	0	0	0	0	16	84	19
Anhimidae	0	0	0	0	1	33	2	67	0	0	0	0	0	0	3	100	3
Anatidae	118	25	67	19	120	34	134	38	11	3	3	1	15	4	350	75	468
Gruidae	6	12	11	26	13	30	17	40	0	0	2	5	0	0	43	88	49
Aramidae	3	75	0	0	1	100	0	0	0	0	0	0	0	0	1	25	4
Rallidae	226	62	8	6	30	22	65	47	28	20	6	4	2	1	130	38	365
Heliornithidae	5	71	0	0	0	0	2	100	0	0	0	0	0	0	2	29	7
Eurypygidae	3	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Jacanidae	13	76	0	0	2	50	2	50	0	0	0	0	0	0	4	24	17
Rostratulidae	3	75	0	0	0	0	1	100	0	0	0	0	0	0	1	25	4
Dromadidae	0	0	0	0	1	100	0	0	0	0	0	0	0	0	1	100	1
Haematopodidae	11	52	4	40	3	30	2	20	1	10	0	0	0	0	10	48	21
Ibidorhynchidae	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Recurvirostridae	10	38	2	13	9	56	2	13	0	0	0	0	3	19	18	62	26
Burhinidae	20	80	0	0	0	0	5	100	0	0	0	0	0	0	5	20	25
Glareolidae	32	68	0	0	6	53	6	40	0	0	0	0	1	7	15	32	47
Charadriidae	92	59	11	17	18	28	33	51	0	0	1	2	2	3	65	41	157
Scolopacidae	109	48	3	3	45	39	63	54	3	3	2	2	0	0	118	52	225
Pedionomidae	0	0	0	0	0	0	1	100	0	0	0	0	0	0	1	100	1
Thinocoridae	10	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Laridae	55	52	24	48	14	28	11	22	0	0	0	0	1	2	50	48	105
Sternidae	113	64	11	17	26	41	22	35	0	0	0	0	4	6	63	36	176
Rynchopidae	2	29	1	20	1	20	3	60	0	0	0	0	0	0	5	71	7
Global Total	**1,105**	**48**	**198**	**17**	**410**	**34**	**435**	**40**	**52**	**4**	**16**	**1**	**39**	**3**	**1,200**	**52**	**2,305**

Table 7. The Globally Threatened status (Red List Category) of all waterbird species for which the category changed between 2002 and 2006. For explanation of the codes, see below Table.

Species	Common name(s)	Red List Status 2002	Red List Status 2006
Rollandia microptera	Titicaca Flightless Grebe, Short-winged Grebe	LC	EN
Phalacracorax neglectus	Bank Cormorant	VU	EN
Phalacracorax bougainvillii	Guanay Cormorant	LC	NT
Phalacrocorax onslowi	Chatham Island Shag	EN	CR
Phalacrocorax featherstoni	Pitt Island Shag	VU	EN
Phalacrocorax pygmeus	Pygmy Cormorant	NT	LC
Ardea humbloti	Madagascar Heron, Humblot's Heron	VU	EN
Ardeola idae	Madagascar Pond Heron	VU	EN
Tigriornis leucolopha	White-crested Tiger-Heron	DD	LC
Balaeniceps rex	Shoebill	NT	VU
Hymenolaimus malachorhynchos	Blue Duck	VU	EN
Anas falcata	Falcated Duck	LC	NT
Anas laysanensis	Laysan Teal, Laysan Duck	VU	CR
Polysticta stelleri	Steller's Eider	LC	VU
Nesoclopeus woodfordi	Woodford's Rail	VU	NT
Galirallus calayensis,	Calayan Rail	–	VU
Gallirallus sharpei	Sharpe's Rail	EXT	DD
Rallus madagascariensis	Madagascar Rail	LC	VU
Crex crex	Corncrake	VU	NT
Amaurornis olivieri	Sakalava Rail, Olivier's Crake	CR	EN
Glareola nordmanni	Black-winged Pratincole	DD	NT
Glareola ocularis	Madagascar Pratincole	LC	VU
Vanellus gregarius	Sociable Lapwing	VU	CR
Charadrius melodus	Piping Plover	VU	NT
Charadrius thoracicus	Black-banded Plover, Madagascar Plover	NT	VU
Charadrius sanctaehelenae	St Helena Plover	EN	VU
Scolopax saturata	Javan Woodcock	–	NT
Scolopax rochussenii	Moluccan Woodcock	VU	EN
Limosa limosa	Black-tailed Godwit	LC	NT
Numenius madagascariensis	Far Eastern Curlew, Australian Curlew	NT	LC
Eurynorhynchus pygmeus	Spoon-billed Sandpiper	VU	EN
Larus bulleri	Black-billed Gull	VU	EN
Pagophila eburnea	Ivory Gull	LC	NT
Sterna lorata	Peruvian Tern	NT	EN
Larosterna inca	Inca Tern	LC	NT

LC Least Concern (*i.e.*, not Globally Threatened); DD Data Deficient; NT Near Threatened; VU Vulnerable; EN Endangered; CR Critically Endangered; EX Extinct

Species whose status worsened between 2002 and 2006 appear in red, those whose status improved appear in green.

Altogether, 24 species have a higher threat status in 2006 than in 2002, and only nine have a lower threat status. The table includes two entirely new species, Calayan Rail, discovered in The Philippines in 2004, and Javan Woodcock, created by a taxonomic split. It is clear that overall, the threat status of Globally Threatened waterbirds worsened to a considerable degree between 2002 and 2006.

Future priorities

This publication is updated every three years, in time for each meeting of the Conference of Contracting Parties to the Ramsar Convention. A draft of this fourth edition was approved by the 9th Conference of the Parties in Kampala, Uganda in 2005, and the next edition will be presented in draft to the 10th Conference of the Parties in Korea in 2008, and published afterwards in 2009.

Wetlands International is committed to increasing the effort it puts into waterbird monitoring, and to making the International Waterbird Census (IWC) a truly global programme. This will result in the collection of ever more data of ever improving quality from an ever increasing number of sites and countries. This activity will provide the basis for the long-term improvements we are seeking in the quantity and quality of waterbird population estimates.

The information in this publication is already available for downloading from the World Wide Web, and it is hoped that in future, interactive web-based dissemination will become the norm, so that users can query the Waterbird Population Estimates database to obtain the information that they need. The internet offers many possibilities for the dissemination of Waterbird Population Estimates data and information which will be explored in future planning.

Only when the limits of each population have been shown on a map will it be possible to determine with any certainty the full suite of range states that are included in each population. The provision of maps showing the limits of individual populations is clearly a priority for the future. A start has been made with addressing this priority by the publication of Flyway Atlases (e.g. Scott & Rose 1996, Miyabayashi & Mundkur 1999). At least one further Flyway Atlas is in preparation, covering waders (shorebirds) in Africa and western Eurasia and the production of similar atlases for additional species in this part of the world is identified as being important in the AEWA Implementation Priorities. The *Waterbird Population Estimates* project has a bright future on the internet, where digital formats have obvious advantages in the presentation of spatial data, which will further enhance its use for the identification of internationally important sites.

Cooperation with Wetlands International networks and partner organisations will continue, as will use of the internet to stimulate interest and contributions to the process of estimation of waterbird populations. There remain many gaps in information which future editions will gradually fill. Any reader with information or data which will facilitate this process is invited to contact the Wetlands International Wageningen office: post@wetlands.org

Oriental Pratincoles, 80 mile Beach, NW Australia. *Chris Hassell*

Waterbird Population Estimates, 2006

In order to avoid misinterpretation of the tables, we strongly recommend that the section on Data Presentation (page 8) is read thoroughly.