Flyway trend analyses based on data from the Asian Waterbird Census from the period of 1987-2020

Compiled by
Tom Langendoen, Taej Mundkur and Szabolcs Nagy

Wetlands International
Wageningen, The Netherlands

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URL: https://iwc-wi.shinyapps.io/eaaf_trends/ for population assessments

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Introduction

Waterbirds are shared resources and shared responsibility. Their conservation and sustainable management and the sites they use is therefore the subject of various international treaties and frameworks, such as the Ramsar Convention on Wetlands, the Convention on Migratory Species (CMS), the East Asian-Australasian Flyway Partnership (EAAFP), Central Asian Flyway Action Plan for migratory waterbirds (CAF) as well as national conservation and hunting legislation.

Flyway-level trend and population size analyses inform international and national management decisions. Population size and trend estimates are used in the global and regional IUCN Red List assessments and for the prioritisation of populations for conservation. The population size estimates provide the basis to setting the so called 1% thresholds to select internationally important sites under the framework of the Ramsar Convention, World Heritage Sites, EAAF Site Network, West/Central Asian Flyway Site Network and the identification of Important Bird Areas.

The flyway-level trend analyses also provide contextual information to national level decisions concerning the management of waterbird populations such as regulating harvest or evaluating the effectiveness of conservation actions including actions at site level.

This report presents the results of this biodiversity monitoring focussed on populations covered by the EAAFP. It contributes to addressing “Key Result Area 3.2 Conservation status reviews for waterbird populations are produced and updated to set and adapt priorities for action.” of Partnership Objective 3 - *Enhance flyway research and monitoring activities, build knowledge and promote exchange of information on waterbirds and their habitats* of the EAAFP 2019-2028 Strategic Plan[1]. This information also contributes to meeting Partnership Objective 5. *Develop, especially for priority species and habitats, flyway wide approaches to enhance the conservation status of migratory waterbirds.*

The methodology used in this report has been developed and tested for analysis of information generated through the African Eurasian Waterbird Census for informing the African Eurasian Waterbird Agreement (AEWA) 7th and 8th Conservation Status Reports and as presented in Nagy and Langendoen (2020).

Since 1987, the Asian Waterbird Census has monitored a large part of Asia and Australasia. The census is carried out by dedicated professionals and thousands of volunteers in 39 countries/regions across the Central Asian and East Asian-Australasian flyways.

Wetlands International and the authors are most indebted to the AWC coordinators and their observer networks. The current or most recent contributing AWC coordinators are Steve Klose (Australia, BirdLife Australia); Enam Ul Haque & Samiul Mohsanin (Bangladesh, Bangladesh Bird Club); Sherub (Bhutan, Ugyen Wangchuck Institute for Conservation &

[1] https://www.eaaflyway.net/wp-content/uploads/2019/07/MOP10_D01_Strategic-Plan-2019-2028_r_MJ.pdf

Environment); Shirley Hee (Brunei Darussalam, Panaga Natural History Society); Hong Chamnan (Cambodia, Wildlife Conservation Society); Wetlands International China Office (China Mainland); Vivian Fu (China Mainland, Hong Kong Bird Watching Society, on behalf of the China Coastal Waterbird Census); Yu Yat Tung (Hong Kong, Hong Kong Bird Watching Society); Woei-horng Fang (Taiwan, Chinese Wild Bird Federation); Da-li Lin (Taiwan, Taiwan New Year Bird Count); P. Sathiyaselvam (India, Bombay Natural History Society); Dhruv Verma (India, Wetlands International); Yus Rusila Noor (Indonesia, Wetlands International Indonesia); Tomoko Ichikawa (Japan, Wildlife Division, Nature Conservation Bureau, Ministry of the Environment Japan); Jin Han Kim & Hwa-Jung Kim (Republic of Korea, National Institute of Biological Resources); Yeap Chin-Aik & Ng Wai Pak (Malaysia, Malaysian Nature Society); Gombobaatar Sundev (Mongolia, Mongolian Ornithological Society); Thet Zaw Naing (Myanmar, Myanmar Bird and Nature Society); Thein Aung (Myanmar, Nature & Wildlife Conservation Division, Forest Department); Hem Sagar Baral (Nepal, Himalayan Nature); David Melville & Adrian Riegen (New Zealand, Ornithological Society of New Zealand); Alan Olsen & Glenn McKinlay (Palau, Belau National Museum); Altaf Hussain & Ali Mehrban (Pakistan, Zoological Survey of Pakistan); Anson Tagtag (Philippines, Biodiversity Management Bureau, Department of Environment and Natural Resources); Igor Fefelov (Russia, Irkutsk State University); Lim Kim Keang (Singapore, Nature Society Singapore); Udaya Sirivardana & Deepal Warakagoda (Sri Lanka, Ceylon Bird Club); Krairat Eiamampai (Thailand, Department of National Parks, Wildlife and Plant Conservation); Ayuwat Jearwattanakanok (Thailand, Bird Conservation Society of Thailand); Alito Rosa (Timor-Leste, Koordinator Konservasi Flora dan Fauna Timor-Leste) and Le Trong Trai (Vietnam, Viet Nature Conservation Centre).

We are thankful to the donors who supported the flyway-level coordination of the IWC: in particular to the Association of the Members of Wetlands International and the Ministry of the Environment of Japan who have supported the staff at Wetlands International. However, we would have nothing to work with without the long-term support provided by other donors to our partners for funding counts at national, regional and site level.

We are also grateful to Arco van Strien, Leo Soldaat and Marnix de Zeeuw of the Dutch Central Bureau for Statistics for their advice concerning the trend statistical analyses.

The Waterbird Fund

This report illustrates that we can only assess the trends of waterbirds if our national and local partners are able to conduct the surveys in their countries and regions. Unfortunately, funding for waterbird monitoring is not available everywhere across the region as national governments also need to attend to other pressing social needs, especially in low- and medium-income countries. Recognising the need for regular and predictable support to waterbird monitoring, the African Eurasian Waterbird Agreement, Ramsar Convention and Convention on Migratory Species called for establishment of the Waterbird Fund. This fund was set up in 2016 and is managed by Wetlands International. If you find the information presented in this report useful and want to help improve monitoring across the flyway, please support the Waterbird Fund. For further information, visit: https://waterbird.fund/.

Materials and methods

Monitoring of waterbirds

In general, populations can be monitored during the breeding season, during the non-breeding (northern winter) season or on migration. Monitoring during the breeding season is most suitable for colonial breeding species or for those dispersed ones that can be relatively easily found during the breeding season. Monitoring during the non-breeding season is most suitable to monitor populations of species that congregate at certain sites or those dispersed species that breed in otherwise inaccessible areas or difficult to observe during the breeding season. Migration counts are particularly useful for those species that are not easy to monitor neither during the breeding or during the non-breeding season but concentrate on a few sites on migration. The suitable techniques depend on the species distribution, behaviour, accessibility of the breeding and non-breeding areas, overlap between the different populations in the given season and practical considerations such as the objectives of monitoring, capacity and costs (Hearn et al., 2018).

The Asian Waterbird Census (AWC)

This report is based on waterbird count data collected during the Asian regional scheme of the International Waterbird Census (IWC). The IWC is a long-term site-based monitoring scheme that started in parts of the Western Palearctic in 1967 and gradually extended to other regions, the Asian programme starting in 1987 (Fig. 1). The IWC has grown into one of the world's largest global biodiversity monitoring schemes.

Originally, the IWC was organised to estimate numbers and to monitor changes in (the northern) wintering ducks and coots, hence it is also commonly referred to as the mid-winter counts, particularly in Europe. Therefore, the core AWC counts are carried out in January across the entire East Asian-Australasian Flyway. In some countries additional or alternative counts have been conducted over the northern winter period, November-December. Generally the January counts have been preferred for AWC analyses but counts from December to February have been used if necessary. In tropical Asia, northern breeding populations of the eastern Palearctic may mix with local populations during the non-breeding counts and some species may not congregate during this period. For these populations, counts from the breeding season are preferred.

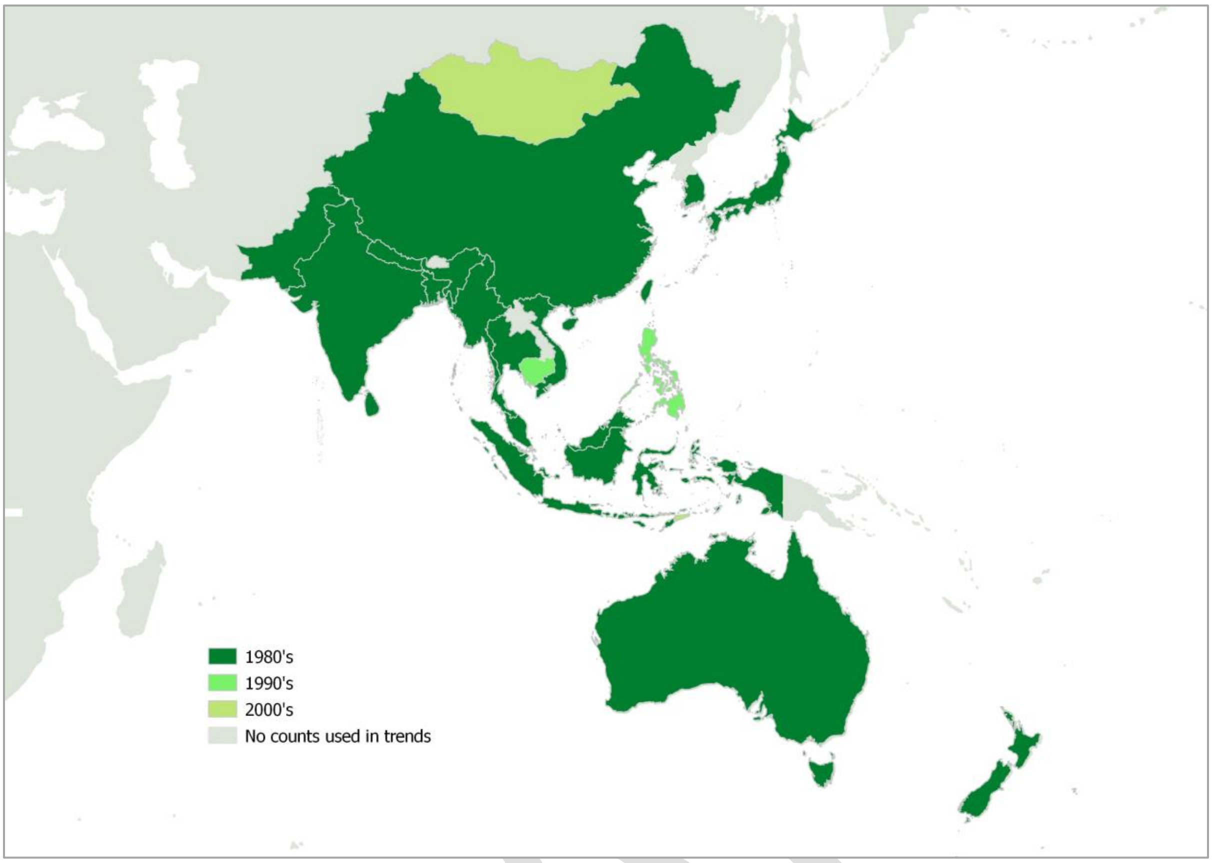

Fig. 1 Start decade for AWC for each country contributing to the EAAF CSR IWC trend calculation.

The AWC operates through national or subnational schemes in each country/region. These schemes are organised by coordinators[2] who are affiliated with government agencies, scientific institutes or non-governmental organisations. In turn, the coordinators work with a large network of professional and volunteer observers. The national/regional AWC schemes contribute to the monitoring obligations of governments under international treaties such as the Ramsar Convention on Wetlands and the EAAFP. Often it is supported by the respective governments. In some countries, the monitoring efforts are largely to completely voluntary and implemented with little funding support. However, in some countries, particularly in low- and medium income ones, the counts are implemented when financial and technical assistance is available, often from external sources. This dependency on funding results in significant variability in coverage, presenting challenges for using the count results to produce population estimates and trend assessments.

Selection of species and populations for analysis

For this report, only about 275 migratory waterbird populations as currently listed under the EAAFP were considered for inclusion. For each population, we considered whether the size and/or the trend of the population can be estimated reliably based on AWC counts and, if not, whether there is any other alternative monitoring scheme in place.

[2] https://www.wetlands.org/our-network/iwc-coordinators/

It is not possible to produce estimates for populations that are mixed with other populations at the time of the AWC counts because allocation of individuals to the different populations would be speculative. For example, the non-breeding areas of some Palearctic breeding populations of herons/egrets like the Great White Egret or Intermediate Egret overlap extensively with the range of the Asian populations of the same species.

Breeding bird monitoring is largely incomplete in Asia and Australasia. In the absence of other data to provide insight into the status of populations in these regions, we sometimes use the AWC data to produce estimates also for populations for which breeding bird monitoring could be theoretically a better option. Seaducks should also be the subject of specialised schemes but trend data is not available at flyway scale.

Available data

The IWC database contains 491,730 count records from 24 countries/regions from 3,212 monitoring sites in the East Asian-Australasian Flyway and from Pakistan, India, Sri Lanka, Nepal and Bhutan[3] (Figures 2 and 3).

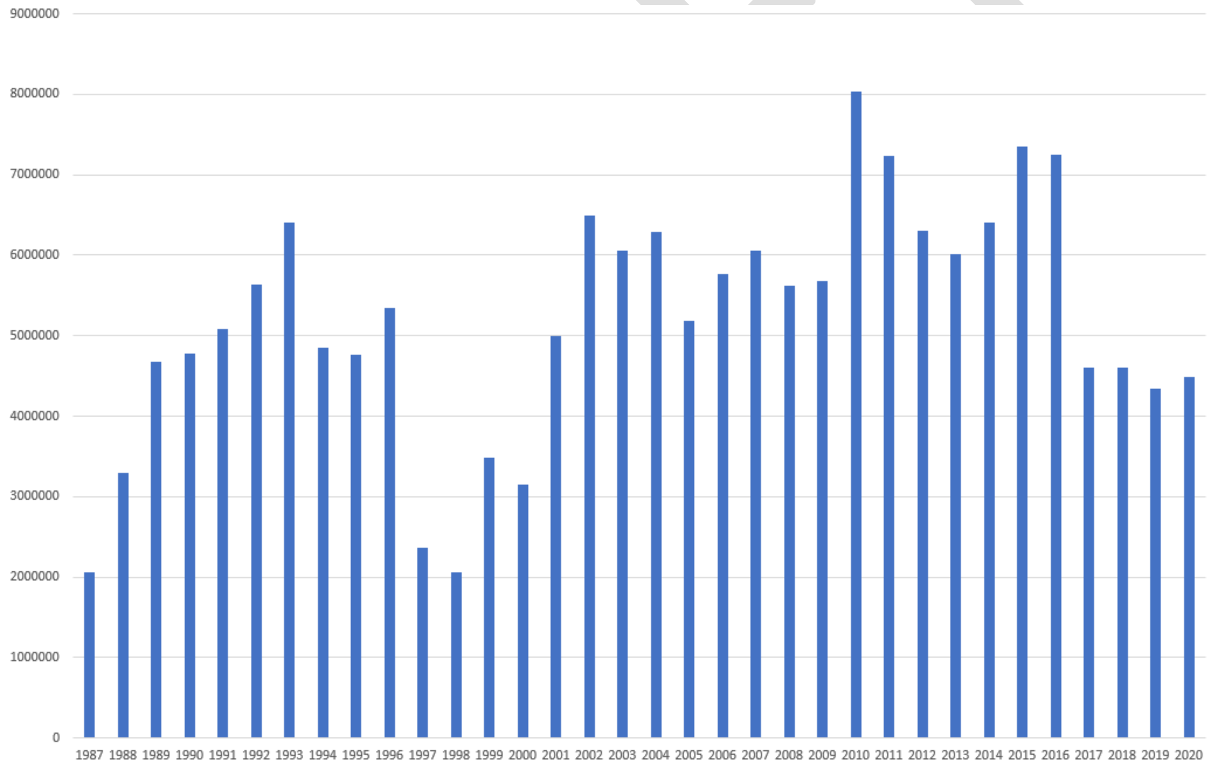

Fig 2. Total number of waterbirds reported each year from countries contributing to the AWC trends

[3] Data from these countries were included for those EAAFP populations that extend into South Asia

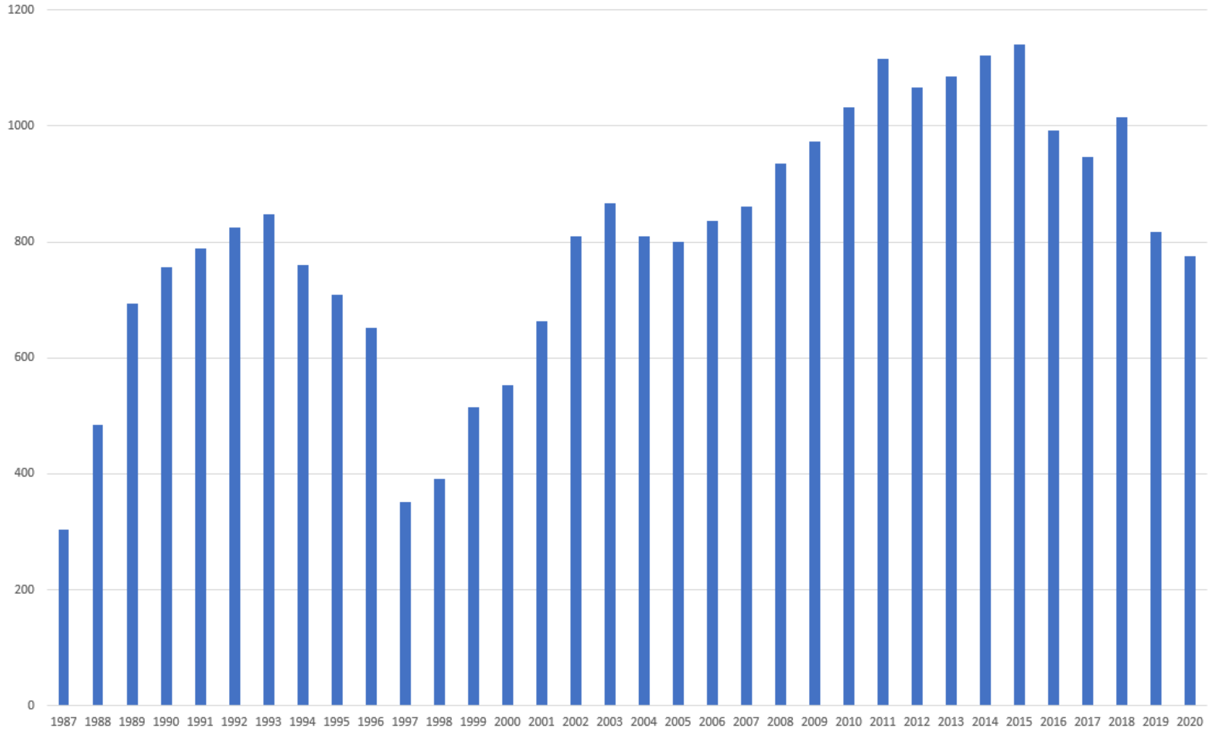

Fig 3. Total number of sites reported each year from countries contributing to the AWC trends

Allocation of count data to populations

Our analyses aim to contribute to the status assessment of the migratory waterbird flyway populations defined in the list of populations covered by the EAAF Partnership and in cases when AWC provides the best available data or where it can be used to triangulate data from other sources (Hearn et al., 2018). We have allocated countries to populations except for where a country is allocated to regions for the analysis. These include Mainland China (Northwest, Tibetan Plateau & Inner Mongolia Plateau, South China (including Hong Kong and Taiwan that are coordinated separately) and Northeast China; as per He et al. 2016), Indonesia (West - Sumatera, Java & Kalimantan), Wallacea region - Sulawesi, Lesser Sundas and partially Maluku and East - partially Maluku & West Papua; as per Eaton *et al.* 2017) and Malaysia (East and West/peninsula). Each country or sub-region was allocated to a single population of a species.

Bangladesh and Northeast India straddle an area of overlap of the EAAF and Central Asian Flyway. Populations included in the EAAF analysis are:

- East and/or Southeast Asian populations that depend on coastal wetlands.
- East and/or Southeast Asian populations, that may extend into eastern India and Bangladesh.

For contiguous populations across inland wetlands of South and Southeast Asia, Bangladesh and Northeast India are allocated to South Asian populations. This reflects the closer linkage between the terminus of migration in Bangladesh with adjoining shared rivers systems, mainly Brahmaputra, with Northern India. We delineate this boundary by the eastern Himalaya and adjoining mountains which separates Myanmar from Bangladesh and Northeast India. This mountainous region holds few large wetlands and likely serves as a barrier between non-breeding populations.

Estimating population size

IWC count data can be used directly to estimate population size only if an (almost) full census is possible. This might be the case for some conspicuous species, concentrated on a few sites that are all well covered by observers and counted at the same time (e.g. some goose populations) in Western Europe. For the majority of populations, annual count totals always represent just a fraction of the entire population. Count totals can be adjusted by imputing for missing counts, allowing an estimation of the population occurring within AWC sites. However, the coverage of the AWC site network varies to a large extent between countries and for different species within a country. Furthermore, the often highly congregatory behaviour of some waterbird species in the non-breeding seasons represents additional difficulties for estimating population sizes based on statistically robust samples because the higher variance requires higher sample size. As a consequence, calibration of count totals to a derived population estimate is mainly limited to dispersed species.

National population size estimates are available for only a few countries and for some waterbird groups. However, few of these estimates are based on statistically robust procedures, instead relying on expert opinion to account for missing, variable or incomplete counts.

Each population account included in this report presents the current population estimates based on the 5th edition of the Global Waterbird Population Estimates (Wetlands International, 2012), the range of count totals for the five-year period of 2016-2020 and a graph showing the evolution of count totals available in the IWC database during the overall trend period reported for the population.

Trend analyses

Following extensive testing, we have decided to apply stricter site selection criteria than in earlier analyses because sites with only a few counts can easily lead to spurious estimates of the imputed annual totals[4] and thus can distort the trend estimates. In this analysis, we have selected sites that have been visited at least 5 times between 1987 and 2020. An additional requirement was to have at least one of the visits within the last 10 years. This resulted in the selection of 3,212 sites from the total of 7,789 for the trend analyses (Fig. 4).

For the purpose of trend analyses, we consider the IWC as a full list method for waterbirds because observers are required to record all species they have seen even if they were not able to count them. Unreported species were considered absent, unless a relevant multispecies group (e.g. unidentified ducks) was reported during the count or for years

[4] Imputed annual totals are the sum of the counted values plus estimates for missing values for sites used in the trend analysis.

before the count of the species group started in a country. This assumption is probably invalid for cryptic species (such as crakes and snipes) or species that are difficult to identify without good optics (e.g. stints). Therefore, we collected information on the reliable start dates per species groups from the national coordinators and used those as the starting year for the national trends. In some cases, this has resulted in shorter overall trend periods than in the last report.

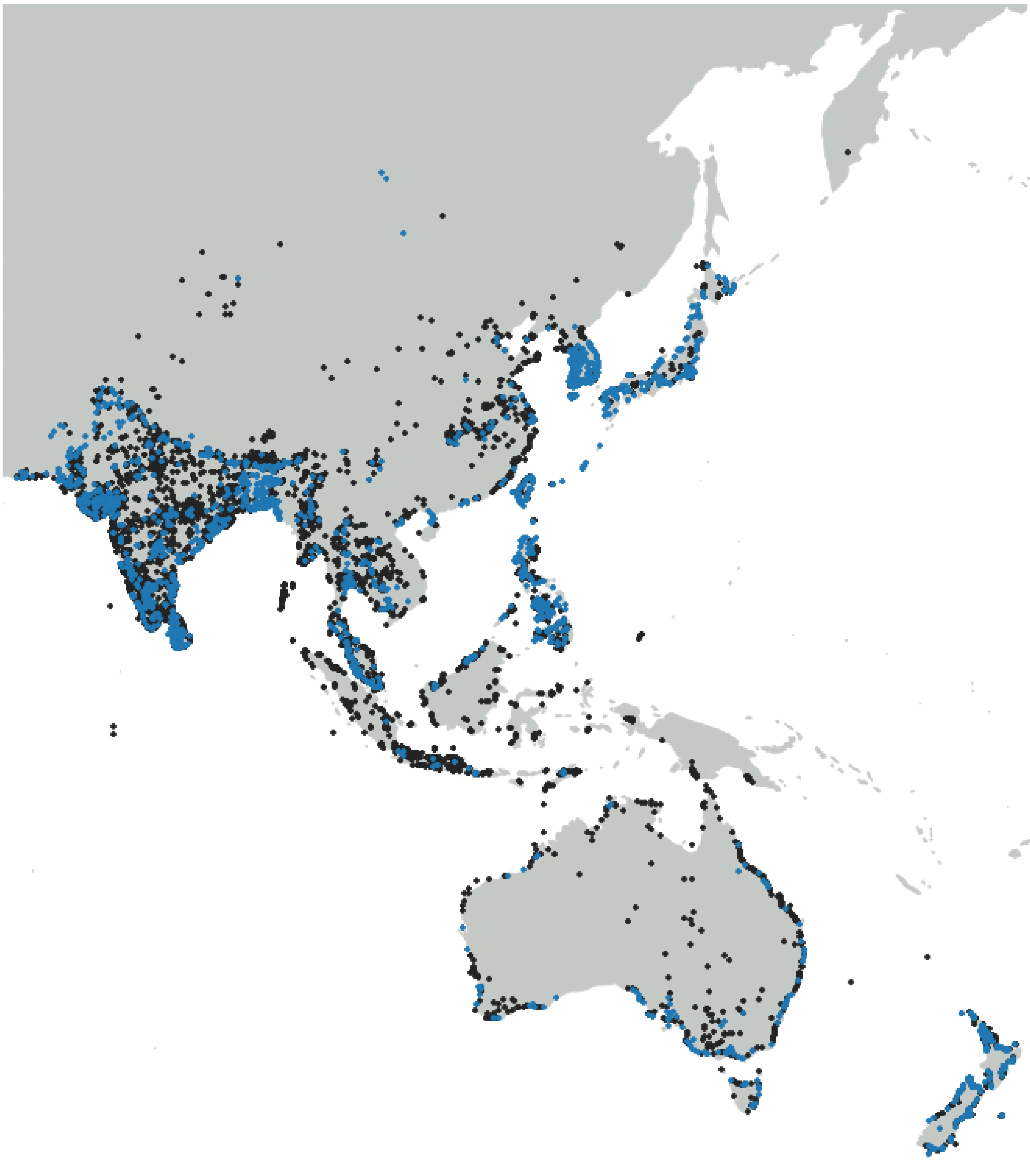

Fig. 4. Sites in the East Asian-Australasian Flyway and other contributing countries from the Asian Waterbird Census. Blue: sites included into the trend analysis, black: sites excluded from the analyses due to insufficient data.

We carried out the trend analyses first at national level and then at population level following the practice of the Pan-European Common Bird Monitoring Scheme (Voříšek et al., 2020). This overcomes the weakness of earlier IWC trend analyses that were carried out at the regional (Delany et al., 1999; Gilissen, Haanstra, Delany, Boere, & Hagemeijer, 2002) or flyway-level (Nagy et al., 2014; Wetlands International, 2012). Working with such combined datasets can amplify the patterns of countries with more regular site coverage. The above-mentioned two-step process can help to remove these biases to some extent. The results of the trend analyses might still be strongly influenced by the national coverage of the AWC. Unfortunately, it is not possible to use weights in the AWC trend analyses as in Pan-European Common Bird Monitoring Scheme to correct for different coverage of the national populations because few countries have produced proper estimates of the national northern wintering populations (e.g. Frost et al., 2019 or Weller, et al., 2020). Most available estimates are simply the IWC count totals and they do not take into account of the effect of missing counts or provide an estimate of the population at areas that were not counted. In certain countries, the wetlands counted support only a small fraction of the population present in the country.

We used the *rtrim* package (Bogaart 2020) for the trend analyses. TRIM is a General Estimating Equation that is able to model missing counts (van Strien & Gibbons, 2001). The Underhill Index (Underhill & Prys-Jones, 1994), widely used in waterbird monitoring, and TRIM produce practically the same imputed values (Bogaart, 2020; van Roomen et al. 2011).

When producing the national trends, we first attempted models with the following settings: Model 2 (i.e. year-effect), automatic change-point removal, serial correlation and overdispersion. For populations with insufficient data, models were attempted without the conditions of serial correlation. We did not use models without automatic change-point removal because that would result in producing a log-linear trend, which is susceptible to producing highly unrealistic estimates if there are a lot of missing counts at national level. National trends were calculated in two steps. First, we calculated an 'exploratory' trend for the period between the first and the last year the country had positive count for the species. Next, we have excluded years with less than 30% of observed data in the imputed totals and truncated the national trend period to the first and last year that met this criterion to reduce the impact of spurious imputing. Years with less than 30% observed values between the first and the last year were treated as missing years for the country in the second run for the country using the truncated time period.

Flyway trends were also produced in two steps. An exploratory flyway population trend was produced based on the national time totals and covariance matrices using data from the second set of national trends. Again, years with less than 30% of observed data in the population imputed totals were excluded and treated as missing years. This left fewer but more reliable annual population estimates in the sample. A third national trend truncated to the period of the flyway trend determined by the previous steps produced imputed national totals and covariance matrices consistent with the period of the flyway trend. We inspected the national trends for spuriously high imputing and made further adjustments either to the national trends or the trend period to exclude unreliable years. In the second flyway TRIM run, missing years were imputed using log-linear trend between years with sufficient data.

After completing the trend analyses, we produced smooth trends using locally estimated scatterplot smoothing (LOESS) on the imputed totals with the settings span = 0.75 and degree = 2, i.e. the standard settings of the MSI (Soldaat et al. 2017).

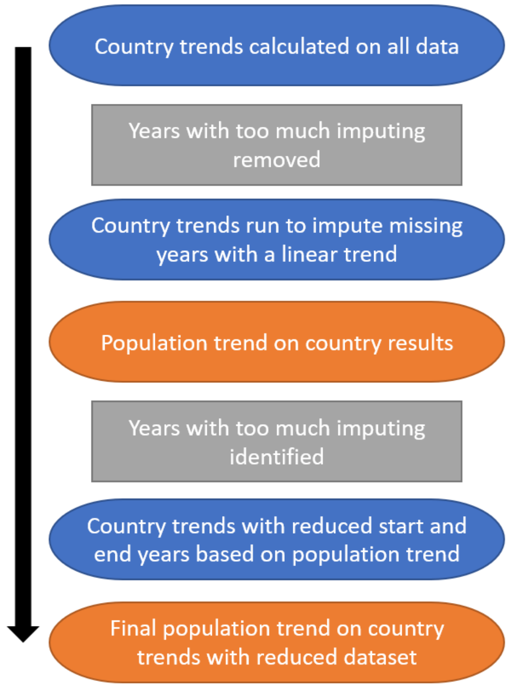

Figure 5. Step-by-step analytical process to calculate population trends.

We report log-linear trends fitted by TRIM for three periods:

- Overall trend: this is the log-linear trend for the entire period analysed. This period provides a long-term perspective;
- 3-generation trend: this covers the period covered by three generations calculated from the last year of the trend period. Generation lengths are based on Bird *et al.* (2020). This period is used for applying the Red List criteria of IUCN (2012) and has also been adopted by AEWA to assess the criterion of long-term decline (2018b);
- 10-year trend: this covers the last 10 year of the trend period, and is very relevant to the EAAF where a number of populations are in rapid short-term decline (e.g. Studds et al. 2017). This period is used for applying the Red List criteria of IUCN (2012) and by AEWA to measure the progress towards the purpose level indicators of the AEWA Strategic Plan (AEWA, 2018a) and assess the rapid short-term decline criterion of AEWA (2018b).

We report the standard trend classification of TRIM:

Assessment	Criteria
Strong increase (more than 5% per year)	lower CI limit > 1.05
Moderate increase (less than 5% per year)	lower CI limit > 1.00
Moderate decrease (less than 5% per year)	upper CI limit < 1.00
Strong decrease (more than 5% per year)	upper CI limit < 0.95
Stable	0.95 < lower < 1.00 < upper < 1.05
Uncertain	any other case

Besides of the standard trend classification, we also report the magnitude of population decreases in three ways, if applicable to the population:

1. Actual population change in 3 generations: this is calculated using the imputed totals of the first and the last year of the 3-generation trend period. We only report it if the estimated decline exceeds 10% in 3 generations;
2. Population change in 3 generations based on growth rate of the overall trend and partly projected in the future: we use this method only if the overall trend period is shorter than 3 generations. We only report it if the estimated decline exceeds 10% in 3 generations and the population trend is not classified as stable;
3. Population change based on the 10-year trend projected into the future for 3 generations: We only report this value if the projected decline exceeds 30%.

Methods 1 and 2 above correspond to the approach for assessing population reduction under criteria A1 and A2 of IUCN and long-term population decline of AEWA (category 3(c) of Column A and category 2(c) of Column B)[5]. Method 3 checks whether the population is projected to decrease at a rate that would qualify the population as threatened (Vulnerable) in the future (IUCN criterion A4) or meets the threshold of rapid short-term decline (AEWA category 3(e) of Column A and category 2(e) of Column B).

It is important to note that reporting these values does not represent our final judgement whether a population is in long-term or in rapid short-term decline or qualifies as a Threatened population. For that assessment we need to assess the reliability of the result of the AWC trend analysis and compare it with other sources of evidence while taking into account the precautionary principle.

Results

Results of the trend analyses of 77 populations are presented on the IWC Online Portal[6].

For each population, we present the following graphs:

- The IWC count totals: showing the unadjusted number of birds counted in a given year for all sites.
- The trend graph: showing totals adjusted for missing counts at the network of monitoring sites that fulfil the site selection criteria.
- The proportional contribution of countries to the imputed totals in any given year.
- Country/regional trend graphs contributing to the flyway trend.
- Map showing the current proposed boundary map of the population and the monitoring sites used in the analysis.

Additional text provides the following information:

- The maximum of the AWC count totals in the last 5 years compared to the population size estimates from WPE5. This indicates if population estimates need to be updated based on the AWC counts.

[5] IUCN (2012) uses a minimum decline of >=30% over 10 years or 3 generations (whichever is longer) to qualify a species as threatened (Vulnerable). AEWA (2018b) uses a reduction in a population by >=10% over 10 years or 3 generations (whichever is longer) to qualify as a declining. The latter threshold is reported for the EAAFP.

[6] https://iwc-wi.shinyapps.io/eaaf_trends/

- The trend statistics for the overall, the 3 generation and for the 10-year trend periods.
- If relevant, the magnitude of the actual or projected population decrease over 3 generations.

The function of this report is only to present the result of the IWC data analysis as one of the inputs into the status assessment of EAAF populations. For many populations the AWC represents the best available information, but not for all. In some cases, there was insufficient data to produce robust trend estimates. Therefore, the results of the IWC trend analyses cannot be used uncritically to assess the status of the EAAF populations. The results of our interpretation of the AWC data and other sources of information are presented on the WPE Portal[7] under the EAAF CSR1 publication.

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