Winter population estimates and distribution changes of two common East Asian dabbling duck species: current status and long-term (1990–2020) trends

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Abstract

Based on survey data from China and Asian Waterbird Census (AWC) data from 14 other countries, the population status and trends of Eurasian Wigeon *Mareca penelope* and Northern Pintail *Anas acuta* (hereafter Wigeon and Pintail, respectively) using the East-Asia Australasia Flyway (EAAF) were estimated for the first time for the 1990s–2020s. In contrast to earlier assessments, more than 98% of the EAAF estimated numbers of Wigeon and Pintail were found to be present in East Asia, with very few counted in Southeast Asia. Their winter abundances were estimated at 250,000 and 220,000 (150,000 and 160,000 in Japan; 90,000 and 50,000 in China; 5,000 and 6,000 in South Korea), respectively in the early 2020s. These current totals compare with the Waterbird Population Estimates (WPE5) of Wetlands International of 500,000–1,000,000 for Wigeon and 200,000–300,000 for Pintail. In the past 30 years, total numbers of both species in East Asia initially decreased and then stabilised, during which time the number of internationally important wintering sites (holding more than 1% of the flyway population) decreased. The majority of Wigeon (73%) and Pintail (87%) were formerly found in coastal areas, where both species have showed significant declines in areas such as the Jiangsu coast, China. Wintering numbers of Wigeon inland increased, while those of Pintail declined. At present, the nine internationally important wintering sites for Wigeon are situated between 36°N and 22°N, while the 26 internationally important wintering areas for Pintail occur at 40°N–22°N. Wintering numbers of both species in Japan are mainly distributed in the south of Hokkaido, whereas in China both species mainly occur in the Yellow River estuary, in southern coastal areas, and along the Yangtze River. In Korea, Pintail are largely restricted to Asan Bay. Based on these results, we draw attention to the urgent need for wetland conservation in China and South Korea to protect both species effectively, and for updated estimates of the numbers of Wigeon and Pintail in Southeast Asia, which in both cases are fewer than 1,000 birds rather than the 80,000 and 20,000 previously estimated.

Key words: Eurasian Wigeon, Northern Pintail, population status, wintering distribution.

Assessing annual avian population size and their trends over time is critical for their conservation and management (Rees *et al.* 2019; Callaghan *et al.* 2021) and supports the goal of the Convention on Biological Diversity to halt and reverse biodiversity loss by 2030. Long-term international cooperation, combined with significant advances in waterbird monitoring and analysis at national, regional and global levels, have provided primary data for Wetlands International to estimate the numbers and trends of waterbird populations worldwide (Rose & Scott 1994, 1997; Wetlands International 2002, 2007, 2012). The East Asian-Australasian Flyway (EAAF) is the region currently showing the most significant population declines among its migratory waterbirds. The EAAF Conservation Status Report (CSR1, Munkdur & Langendoen 2022) published in July 2022 provided current and historical population estimates, trends, and 1% thresholds for 216 waterbird species and 276 biogeographic populations along this migration route (Mundkur & Langendoen 2022). Nevertheless, on this migration route, the population estimates generated for many species of ducks in the review were based on data from the 1990s (Wetlands International 2002). Earlier analyses showed a major gap between the actual population numbers and the historical estimates generated for many species (Cao *et al.* 2008), so more accurate estimates were urgently needed to provide an effective basis for conservation actions.

The migratory birds of the EAAF are among the world's most vulnerable because of Asia's large population and booming economies (Wetlands International 2012). Waterbirds of the EAAF predominantly breed in far eastern Russian, Alaska, the Mongolian Plateau and the Amur River basin, and winter in East Asia, Southeast Asia, Australia and New Zealand, across 22 countries and territories. Anatidae (geese, swans and ducks) have the most significant number of species and populations (50 species; 63 populations), a total of 20,000,000 birds (second only to the gulls, which number 40,000,000), and represent the dominant group of non-breeding (*i.e.* breeding north of this range) waterbirds in East Asia. Geese and swans mainly spend the northern winter in East Asia, including Japan, South Korea, North Korea and China. Population estimates for these species are longer established, because their conspicuous nature and more geographically restricted wintering area makes international cooperation easier (Cao *et al.* 2008, 2020; Jia *et al.* 2016). Duck species are generally thought to range further south of wintering geese and swans, including extending to the southeast coast of China and 11 countries in Southeast Asia (Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, the Philippines, Singapore, Thailand, Vietnam, Laos and Timor-Leste, among others), yet our knowledge of these species lags behind that of the larger-bodied waterbirds. Therefore, along the migration corridors of the EAAF, we see it as a priority to extend the contemporary waterbird count coverage within East Asia (especially in China) to Southeast Asia, to characterise the status and trends in abundance of duck species effectively.

In earlier Asian Waterbird Census (AWC) reports (Li & Mundkur 2007; Mundkur *et al.*

2017), most of the data on wintering waterbirds in the EAAF came from Japan, Korea and Taiwan (East Asia region), where count coverage has been good and consistent over many years. The Philippines and Thailand (Southeast Asia), India, Nepal, Sri Lanka, Bangladesh and Pakistan (South Asia), New Zealand and Australia (Oceania) also have well-established monitoring networks, while other countries provided limited data on the abundance and distribution of waterbirds. In China, until recently, the vast number and area of wetlands resulted in major challenges to effective waterbird monitoring, resulting in limited contributions to earlier AWC assessments (Mundkur & Langendoen 2022). The accuracy of EAAF population size estimates is affected by the lack of regular, systematic waterbird survey data from North Korea, Laos and Timor-Leste, and until recently in China, which we now know to be the main wintering area for some duck species such as Eurasian Wigeon *Mareca penelope* and Northern Pintail *Anas acuta* (hereafter Wigeon and Pintail). The CSR1 process was not able to make a full assessment of waterbird abundance in Southeast Asia. For example, of the 39 different duck populations along EAAF, only one population estimate was based on a complete population census, while the remaining 38 population estimates are based, to a varying extent, on guesswork. Further monitoring, research and conservation efforts therefore are urgently needed.

China, in particular, is a critical duck-wintering area along the EAAF (Cao *et al.* 2010), where many species (*e.g.* Baer's Pochard *Aythya baeri* and Scaly-sided Merganser *Mergus squamatus*) have shown declining trends in the past 30 years (Barter *et al.* 2012; Wang *et al.* 2012). Although estimates of overwintering duck numbers were first presented in 2008 (Cao *et al.* 2008), mainland China does not provide regular national monitoring reports to the AWC, and many species lack basic data upon which to base population size estimate updates. Owen & Williams (1976) found that Wigeon in Europe tended to move from coastal areas to inland areas due to habitat change, and it is likely that this process has also been happening in China in the last 30 years. The extent of China's natural wetlands decreased by *c.* 61,000 square kilometers between 2000 and 2015 (Peng 2010; Xu *et al.* 2019). The loss of coastal wetlands behind massive constructed embankments has been called the new "Great Wall" of China (Ma *et al.* 2014), and it is clearly important to study the impact of such rapid changes in wetland areas on the number and distribution of duck species in China. At the same time, the distribution of wintering waterbirds is extending northwards due to warmer winters, which permit their use of previously frozen areas such as the Yellow River basin and areas even further north for wintering (Cao *et al.* 2010; Ga *et al.* 2022), continuing the northward progression of wintering waterbirds first reported by Cao & Barter (2008). For these reasons, it is clearly important to monitor changes in the distribution and abundance of these common duck species.

The Wigeon is distributed across all of Eurasia, numbering an estimated 3.01 million individuals, divided between five populations (Wetlands International 2012, Supporting Materials Fig. S1). Of these five, the East Asian population is one of only two declining populations. Pintail are distributed across the entire Northern Hemisphere, numbering an estimated 8.18 million birds, divided into six populations, of which the East & Southeast Asia population is one of the three populations with a declining trend (see Fig. S1, Table S1). In the EAAF, both species showed a downward trend during 1977–1991 (Fig. 1; BirdLife International 2017, 2019), but subsequent lack of systematic surveys and studies of EAAF populations precludes more recent estimations of abundance and trends (Mundkur & Langendoen 2022). Because China was traditionally the main wintering area in the EAAF for both species, supporting *c.* 500,000 individuals combined 30 years ago (Lu 1995, 1996), changes in abundance there are of critical importance for the flyway abundance of Wigeon and Pintail.

In this study, we attempt to estimate the changes in abundance and distribution of Wigeon and Pintail in China and the EAAF since the 1990s, as a model for estimating the population trends for other species with similar non-breeding distributions. We will also use these analyses to identify critical sites along the EAAF (including East and Southeast Asia) as a basis for future species and habitat conservation management.

Methods

The huge geographical range of waterbirds nesting at low densities on the breeding grounds makes it difficult to assess annual changes in their population abundance in these areas. As a result, population estimates are more often based on counts undertaken on the wintering grounds where, having completed migration, populations are more concentrated and static than at other times of year. In this paper, we attempt to estimate the total numbers of Wigeon and Pintail throughout the entire EAAF in the 1990s, 2000s and 2020s on the basis of 15 national reports published annually in the Asian Waterbird Census (presented in Table S2). We attempt to do this at three different scales. First, we compare wintering population estimates for Wigeon and Pintail in eastern China in the 1990s (published in Lu 1996) and 2000s (based on Cao *et al.* 2008) with new population estimates from the 2020s, estimated here for the first time. Second, we combine midwinter waterbird count data from China with those from Japan and South Korea to provide an assessment of changes throughout East Asia. Finally, we examine similar data from 11 countries in Southeast Asia to assess the abundance of Wigeon and Pintail in this part of the flyway.

Wintering abundance estimates for eastern China

China is central within the EAAF migration corridor, providing a vast area of wetlands (*c.* 10% of global extent, Xu *et al.* 2019) for migratory waterbirds flying north and south. The terrain in China is higher in the west and lower and flatter in the east, where the major river floodplains are concentrated. As a result, EAAF migratory ducks mainly overwinter in the area east of 110°E in China (Cao *et al.* 2008). The January zero-degree isotherm is located between the

Qinling Mountains and the Huaihe River, and wetlands south of the isotherm do not freeze in the coldest month of January. For the purposes of this study, we divide the region into three regions based on the zero isotherm: inland and coastal China, and Taiwan. The inland region was further divided into: (1) the Yangtze River, (2) Huaihe River, (3) Yellow River, and (4) the north. The coastal region was divided into four areas: (a) the area north of the Yellow River estuary, (b) the Yellow River estuary and (c) to its south, and (d) Hong Kong and Taiwan (Table S3). Inland waterbirds are concentrated in the wetlands of the middle and lower reaches of the Yangtze River, while some are distributed in the Huaihe and Yellow River basins (Cao *et al.* 2010; Prosser *et al.* 2018). Of these, the Yangtze River basin has by far the greatest density of shallow lakes in China and the most concentrated wetland distribution in the same latitude region. During summer precipitation, water levels rise, falling during the autumn and winter, exposing vast shallow wetlands that provide abundant food and suitable habitats for millions of wintering waterbirds (Cao & Fox 2009). China's coastal areas from the north of the Yellow Sea to the south of the South China Sea support approximately 12,000 km^2 of intertidal habitats (Murray *et al.* 2019). The tidal flats in the Yellow Sea are up to 20 km wide, among the broadest in the world (Healy *et al.* 2002; Barter *et al.* 2005). There are also many bays, river mouths and extensive mudflats in the East China Sea and South China Sea (Wang *et al.* 2002). Coastal areas are more influenced by sea surface temperatures and are warmer than corresponding areas further inland, with the January zero-degree isotherm located north of the Huaihe River in the coastal area of Jiangsu Province.

We estimated population abundance for three time periods, based on data from China's inland, coastal and Taiwan regions. Data for mainland China in the 1990s were obtained from the overwintering survey data of the "Waterbird Research in China, 1994" (1989/90–1992/93; Water Bird Group of the Chinese Ornithological Society 1994) and survey data from the Hong Kong Bird Watching Society (1987/88–1991/92); data for Taiwan were derived from the Li & Mundkur (2004) report (1996/97–1998/99). Count data from the 2000s came from Cao *et al.* (2008); see Table S3 for details. The data sources for the 2020s are as follows: inland areas including: (1) the Yangtze River and (2) the Huaihe River originate from synchronous surveys of overwintering waterbirds in the Yangtze River in 2018/19 and 2019/20 (December–February) carried out by Cao's group and the synchronous survey of wintering waterbirds in the Huai River in 2015/16 (December–February, with (3) eBird data (https://ebird.org/home) from 2015/16 to 2020/21 used to generate estimates of abundance in the Yellow River and areas to the north. Coastal areas included data from: (1) north, and (2) south of the Yellow River estuary, as well as data provided by co-authors (2015/16–2000/21, Table S4) and the Hong Kong Bird-Watching Society (2016/17–2020/21). Data from Taiwan were taken from the wintering survey data published on GBIF (Global Biodiversity Information Facility) from the NYBC (Taiwan New Year Bird

Count) (2016/17–2019/20, Lin 2021). Data from 1987/88 to 1998/99 were used to calculate population estimates for the 1990s, 2003/04 to 2006/07 for the 2000s, and 2015/16 to 2020/21 for the 2020s.

We here use the 1990s population estimates published by Professor Lu Jianjian (in Lu 1996) which considered wintering numbers of both Wigeon and Pintail in China to be > 500,000 individuals. These estimates were generated on the basis of raw site-based count data from the Water Bird Group of the Chinese Ornithological Society (1994), combined with "guestimates" of numbers missed in various regions/ provinces in eastern China at that time. Very few birds in western China included 2,027 Wigeon (2,000 in Caohai) and 3,130 Pintail (3,000 in Caohai). For the surveys carried out in the 2000s and 2020s, the look-see method (Bibby *et al.* 2000; Delany 2005; Cao *et al.* 2008) was used to identify and count all ducks in wetlands from as many vantage points as possible at each wetland. Ducks usually form large visible groups during the winter and are easy to locate and calculate. Based on the methods of Cao *et al.* (2008), the total eastern China population sizes of Wigeon and Pintail were estimated based on the counts from surveyed wetlands using three methods to correct for potential causes of error. First, assuming duck species are dispersed at even density across a given wetland, the total number of a given species at a site was generated by correcting for the proportional area of that wetland that was inaccessible to counters by the numbers counted in fully counted sections (Table S5). For example, the areas of the large Caizi Lake counted in 2019 and 2020 represented 80% and 90% of the total wetland area, respectively, so the totals generated for this site were corrected upwards for the areas not counted. Elsewhere, the extent of count coverage was very much higher. Overall, the total degree of wetland area counted was estimated to be 72% (s.d. = 22%, n = 129, range = 30–100%) in the 2000s (Rappoldt *et al.* 1985; Cao *et al.* 2008) and 78% (s.d. = 21%, n = 134, range = 30–100%) in the 2020s, and hence changed little between these two periods (Table S5). Second, in the field, conditions result in a certain proportion of birds present in areas covered during the count being missed by observers, for instance, due to dense vegetation cover, poor visibility (mist and fog), or inexperienced observers. This was taken into account by adjusting the count to include species-specific detection rates, with larger-bodied species having higher detection rates; detection rates for Wigeon and Pintail are both set at 80% (Cao *et al.* 2008). Finally, we estimated that the counts covered 80% of the total extent of suitable duck habitats in eastern China, and so we adjusted the total number of Wigeon and Pintail upwards to account for the areas missed.

To give an example of how this works for Wigeon using data from the 2020s, we start with the raw count data which generated a total of 41,988 individuals. After correcting for site-specific count coverage within all of the individual sites (range = 30–100%), this generated an estimated total of 52,533 birds, which corrected for an 80% detection rate gives 65,666 individuals. Finally, correcting for suitable habitat at sites not counted provided a final estimate of *c.* 82,000 individuals (see Table S6).

Wintering abundance in Japan and South Korea

Since 1970, the Ministry of the Environment of Japan and local governments have conducted annual monitoring of wintering waterbirds, with the number of survey sites increasing from 171 to 9,375, covering all 47 prefectures in Japan (Ministry of the Environment 2021). Population estimates from the 1990s were based on the mean of survey data from 1987/88–1991/92, while population estimates from the 2000s were sourced from Cao *et al.* (2008), with the mean of survey data from 2016/17–2020/21 used to calculate population estimates for the 2020s. The survey data from South Korea was based on counts carried out under the Nationwide Winter Waterbird Census (NWWC) conducted by the Ministry of Environment and related institutes, the National Institute of Environmental Research (NIER) (1999–2007), and the National Institute of Biological Resources (NIBR) (since 2008) (NIBR 1999, 2021). The data from 1998/99 was used to calculate population estimates for the 1990s (the only survey data available for that period).

Wintering abundance in Southeast Asia

We used published data from Li & Mundkur (2004, 2007) and Mundkur *et al.* (2017) to investigate changes in abundance of Wigeon and Pintail in Southeast Asia. Data submitted by each country to the AWC during 1996/97–1998/99 were used for population estimates in the 1990s (Table S2), survey data from 2002/03 to 2004/05 were used for population estimates in the 2000s, and data in 2014/15 (the closest survey year to 2020) was used for 2020s. For Timor-Leste (2008/09) and Laos (1999/2000), data from the only surveys reported in the past 30 years were applied to population estimates in the 2000s. In addition, eBird data were used as a source of supplementary data, with the period of data selection being the same as that extracted from the AWC report.

To detect and estimate trends in national abundances, we used applied simple linear regression analysis to the logarithm of population estimates as the dependent variable and year as the independent variable and compared the resulting estimates with those from the EAAF CSR1 (Mundkur & Langendoen 2022).

Internationally important wintering sites

The 1% threshold for Wigeon and Pintail was 7,100 and 2,400 birds, respectively, based on the EAAF CSR1 (Mundkur & Langendoen 2022, Table S7). We used these figures to classify wintering sites of international importance for each country, based on whether the maximum count equalled or exceeded this threshold, and compared these sites across the three time periods (the 1990s, 2000s and 2020s).

Shifts in proportions of coastal and inland wintering ducks

We also calculated the proportion of Wigeon and Pintail using coastal habitats for each of the three time periods. For China, we divided the adjusted coastal population estimates by the adjusted total population estimates for eastern China. Data for for Japan and Korea were similarly treated (including data from 1998/99, which provided the only survey records for that decade).

Results

Population estimates and trends in East Asia

In the past 30 years, the trends for East Asia show Wigeon numbers initially declined (by 63%) between the 1990s and the 2000s, since when numbers have stabilised (651,500 in the 1990s; 241,200 in the 2000s; 251,400 in the 2020s; Table 1, Fig. 1).

In East Asia, China formerly supported the greatest numbers of wintering Wigeon (504,400) in the 1990s, but in the 2000s these decreased by 90%. Although there was a subsequent increase in numbers to 91,300 in the 2020s, this constituted only 18% of the total reported 30 years ago (Fig. 2, Table 2). Japan supported the second largest numbers of Wigeon in the 1990s (126,700), increasing to 182,400 in the 2000s, since when it has consistently supported most of the Wigeon wintering in East Asia with little subsequent change (154,100 in the 2020s; $F_{1,30}$=1.84, r^2 = 0.06, b = 0.001, P = 0.19). In South Korea, numbers peaked at 20,400 Wigeon prior to our main study period (*i.e.* > 30 years ago), but there are now fewer than 10,000 birds, a significant decline in abundance ($F_{1,21}$ = 7.54, r^2 = 0.26, b = –0.01, P = 0.012). In the 2020s, these three countries in East Asia accounted for the vast majority of Wigeon in this biographical sub-population (n = 251,500 individuals): Japan (61%), followed by China (36%) and Korea (2%).

Over the past 30 years, numbers of Pintail in East Asia have declined dramatically (by 65%), from 694,900 in the 1990s to 245,800 in the 2000s, and then seemingly stabilised at 223,800 by the 2020s (Table 1, Fig. 1). China supported the largest numbers wintering in East Asia during the 1990s (*c.* 503,500), but these declined to 47,600 in the 2000s and then stabilised (51,900) in the 2020s. Japan ranked second importance, supporting an estimated 168,900 in the 1990s, but numbers there have dropped slightly since then, with 165,300 in the 2020s ($F_{1,30}$ = 5.58, r^2 = 0.16, b = –0.002, P = 0.02). In South Korea, the population peaked at 22,500 30 years ago and is now less than 10,000 ($F_{1,21}$ = 43.77, r^2 = 0.68, b = –0.04, P < 0.01). In the 2020s, three East Asian countries accounted for almost all Pintail in the EAAF, n = 224,200: Japan (74%), China (23%) and South Korea (3%).

Wintering abundance in Southeast Asia

Based on data from the AWC and other data sources, the counts of Wigeon from the five Southeast Asian countries (Philippines, Vietnam, Thailand, Myanmar and Laos) accounted for only 1% or less of the flyway population (contributing less than 1,000 individuals). Likewise, the maximum number of Pintail counted in same five countries accounted for about 2% or less of the total, with highest count of *c.* 4,000 in the 2000s (Table 1, Table S8). We conclude that this region contributes relative little to the overall population size of either species.

EAAF population estimate

Based on all sources of data combined, we can show that, in the 2020s, the numbers of Wigeon wintering along the EAAF was 251,500, including 251,400 in East Asia and

Table 1. Changes in abundance of Wigeon and Pintail wintering in the EAAF across the three periods.

Location	**Wigeon abundance**			**Pintail abundance**		
	1990s	**2000s**	**2020s**	**1990s**	**2000s**	**2020s**
China ① Chinese mainland	500,000[d]	50,000[g]	82,000[d]	500,000[d]	46,000[g]	47,000[d]
② Taiwan (China)	4,400[i]	2,200[g]	9,300[h]	3,500[i]	1,600[g]	4,900[h]
Japan	126,700[e]	182,400[g]	154,100[e]	168,900[e]	175,800[g]	165,300[e]
South Korea	20,400[f]	6,600[g]	5,200[f]	22,500[f]	22,400[g]	6,400[f]
North Korea	–	–	800[j]	–	–	200[j]
Total for East Asia	**651,500**	**241,200**	**251,400**	**694,900**	**245,800**	**223,800**
Total for Southeast Asia[i]	**1,000**	**800**	**100**	**1,400**	**4,100**	**500**
New estimates	**652,500**	**241,900**	**251,500**	**698,100**	**249,800**	**224,200**
China%[a]	77	22	36	72	19	23
Japan%[a]	19	75	61	24	70	74
South Korea%[a]	3	3	2	3	9	3
Southeast Asia%[a]	0	0	0	0	2	0
The populations of EAAF IN 2020s[b]	710,000	710,000	710,000	240,000	240,000	240,000
%[c]	92	34	35	291	104	93

[a]Percentage that the estimated numbers in a country/region contributes to the total estimated EAAF population.
[b]Current estimate provided by Wetlands International for the flyway population in the 2020s.
[c]Percentage that the calculated new population estimates contribute to current 2020s Wetlands International populations of EAAF.
[d]Population estimates from China, so mid-points used here to represent the range.
[e]Data from the Ministry of the Environment of Japan.
[f]Data from Korean Ministry of Environment and its associated institutes, NIE and NIBR.
[g]Cao *et al.* (2008).
[h]GBIF data (Lin 2021).
[i]Li & Mundkur (2004, 2007); Mundkur *et al.* (2017).
[j]Maximum numbers reported to the AWC 2016–2020.

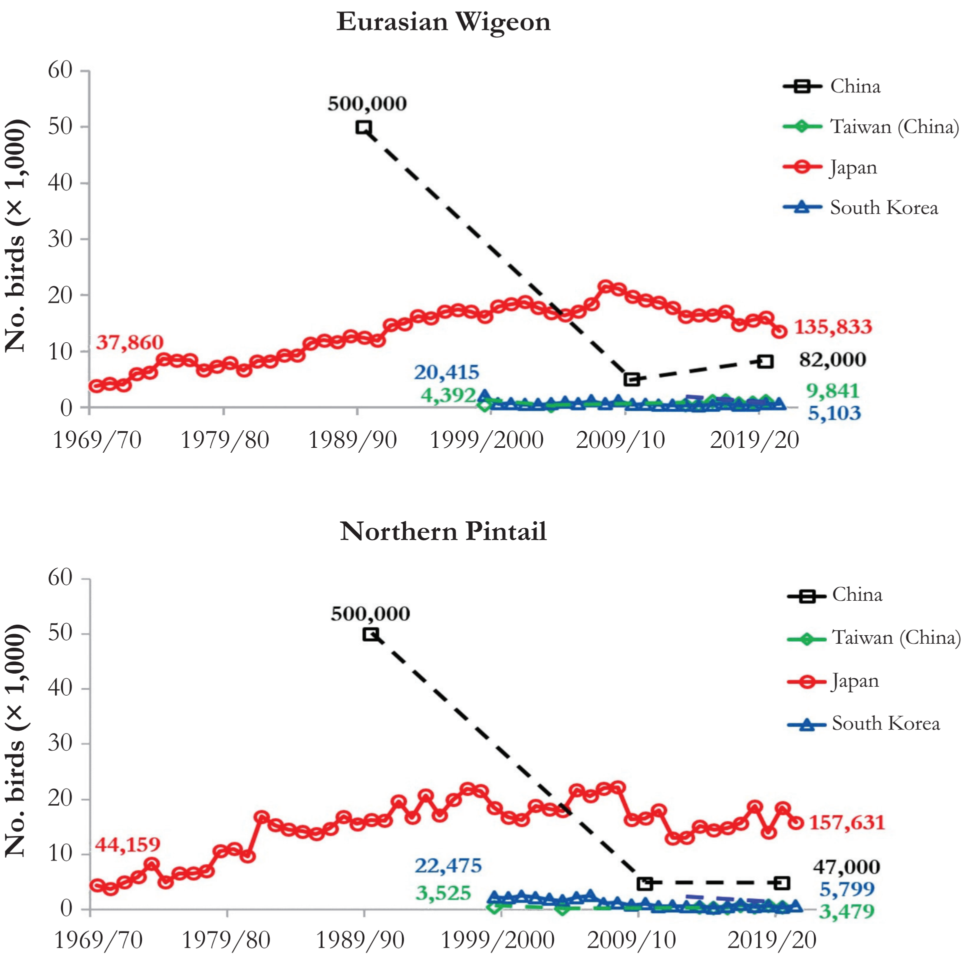
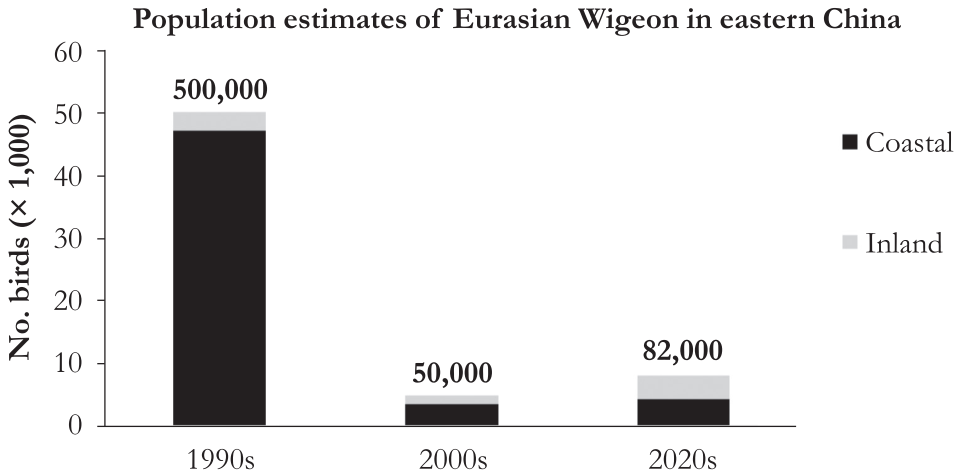


Figure 1. Changes in abundance of Wigeon and Pintail in China (mainland and Taiwan), Japan and Korea over five decades of available counts.

74 in Southeast Asia. From the 1990s to 2020s, East Asia accounted for more than 99% of the total population, while the five Southeast Asian countries accounted for only 1% or less (Table 1 & Table S8).

Similarly, numbers of Pintail wintering along the EAAF in the 2020s were estimated at 224,000, including 223,500 in East Asia and a little more than 500 in Southeast Asia. Throughout all three periods, numbers of Pintail counted in East Asia accounted for more than 98% of the EAAF total numbers (Table 1 & Table S8).

In conclusion, the number of Wigeon and Pintail in the 2020s along the EAAF was 250,000 and 220,000, respectively (accounting for 35% and 93% of EAAF estimates in CSRI, respectively). Based on the data



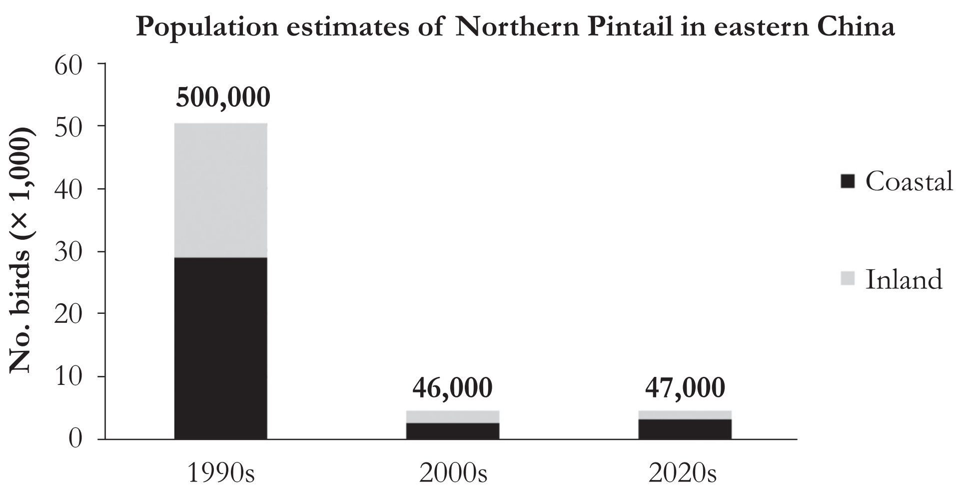


Figure 2. Estimated population sizes for Wigeon and Pintail in China in the 2000s to the 2020s (Wigeon: 24,141 in the 2000s; 41,988 in the 2020s. Pintail: 21,704 in the 2000s; 24,368 in the 2020s). Previous estimates for the 1990s are estimates published by Professor Lu Jianjian in Lu (1996) (Wigeon: 500,000; Pintail: 500,000), based on annual raw data published by the Water Bird Group of the Chinese Ornithological Society (1994) (Wigeon: 44,177; Pintail: 32,974). Light grey = inland; black = coastal.

presented here, the Wigeon and Pintail wintering in East Asia had apparently accounted for more than 98% of the total number along the EAAF, the remainder contributed from sites in Southeast Asia.

Internationally important wintering sites

Along the EAAF, the internationally important sites identified for Wigeon were all located in East Asia (Fig. 3, Table 3,

Table 2. Annual estimates of Wigeon and Pintail abundance in China in the 1990s, 2000s and 2020s, based on various sources of data fully described in the text. Count data and information were derived from literature sources; survey data were provided by co-authors, and unpublished wintering data were from Cao Lei's group's wintering survey in the Yangtze River (December–February). Note that contributing data from Jiangsu, Huaihe, Hubei Chen Lake and Beijing in the 2000s were from November–March.

Region	**Wigeon**			**Pintail**		
	1990s	**2000s**	**2020s**	**1990s**	**2000s**	**2020s**
① Yangtze River	22,400[a]	9,800[c]	37,500[c]	203,800[a]	18,600[c]	14,400[c]
② Huaihe River	3,700[a]	2,100[d]	0[d]	6,800[a]	5[d]	0[d]
③ Yellow River and its north	200[a]	2,100[e]	0[h]	0[a]	0[e]	0[h]
Inland total	**26,300**	**14,000**	**37,500**	**210,700**	**18,600**	**14,400**
① North of the Yellow River estuary	0[a]	500[e]	37[i]	1,100[a]	1,100[e]	15[i]
② Yellow River estuary and its south	458,600[a]	28,900[g]	32,100[i]	206,900[a]	20,200[f]	25,600[i]
③ Hongkong	15,100[b]	6,600[b]	12,400[b]	81,300[b]	6,100[b]	6,900[b]
Coastal total	**473,700**	**36,000**	**44,500**	**289,300**	**27,400**	**32,600**
Estimation of population in mainland China	**500,000[k]**	**50,000**	**82,000**	**500,000[k]**	**46,000**	**47,000**
Taiwan (China)	4,400[g]	2,200[g]	9,300[j]	3,500[g]	1,600[g]	4,900[j]
China total	**504,400[l]**	**52,200[l]**	**91,300[l]**	**503,500[l]**	**47,600[l]**	**51,900[l]**
① Proportion of Yangtze River	4	19	41	40	39	28
② Proportion of Huaihe River	1	4	0	1	0	0
③ Proportion of Yellow River and its north	0	4	0	0	0	0
Proportion of inland	5	27	41	42	39	28
① Proportion of north of Yellow River estuary	0	1	0	0	2	0

Table 2 (*continued*).

Region	**Wigeon**			**Pintail**		
	1990s	**2000s**	**2020s**	**1990s**	**2000s**	**2020s**
② Proportion of Yellow River estuary and its south	91	55	35	41	42	49
③ Proportion of Hongkong	3	13	14	16	13	13
Proportion of coastal	**94**	**69**	**49**	**57**	**58**	**63**
Proportion of mainland China	**99**	**96**	**90**	**99**	**97**	**91**
Proportion of Taiwan	**1**	**4**	**10**	**1**	**3**	**9**

[a]Literature data from 1990 to 1993 published by the Water Bird Group of the Chinese Ornithological Society (1994).
[b]Survey data from Hong Kong Bird Watching Society during 1990 to 2021.
[c]Survey data of wintering waterbirds in the Yangtze River from the Cao group in 2004, 2005, 2019 and 2020.
[d]Survey data of wintering waterbirds in the Huai River from 2006 to 2007 and 2016 (December and February).
[e]Cao *et al.* (2008).
[f]Survey data of wintering waterbirds along the coastal of China in 2006 and 2007 (November to February).
[g]Li & Mundkur (2004, 2007).
[h]eBird online data from 2016 to 2020, maximum overwintering counts at different sites were counted from December to February each year (Comell Lab of Ornithology 2021).
[i]Coastal shared data from 2016–2021 provided by the co-authors and from Li *et al.* (2020b).
[j]Wintering survey data from 2016/17 to 2019/20 published on GBIF by Taiwan New Year Bird Counting Carnival (Lin 2021).
[k]Population estimates for the 1990s used the median of the maximum and minimum estimates published by Lu (1996).
[l]China total is the sum of the estimated numbers from mainland China and Taiwan combined.

Table S9). There are 11 (eight in Japan, two in China and one in South Korea), 14 (Japan alone) and 9 (six in Japan, three in China, but none in South Korea) internationally important wintering sites in the 1990s, 2000s and 2020s, respectively.

In the past 30 years, most of the internationally important wintering sites for Wigeon along EAAF were located in the coastal area (6–13 sites), while few were inland (one to two). The number of internationally important wintering sites in

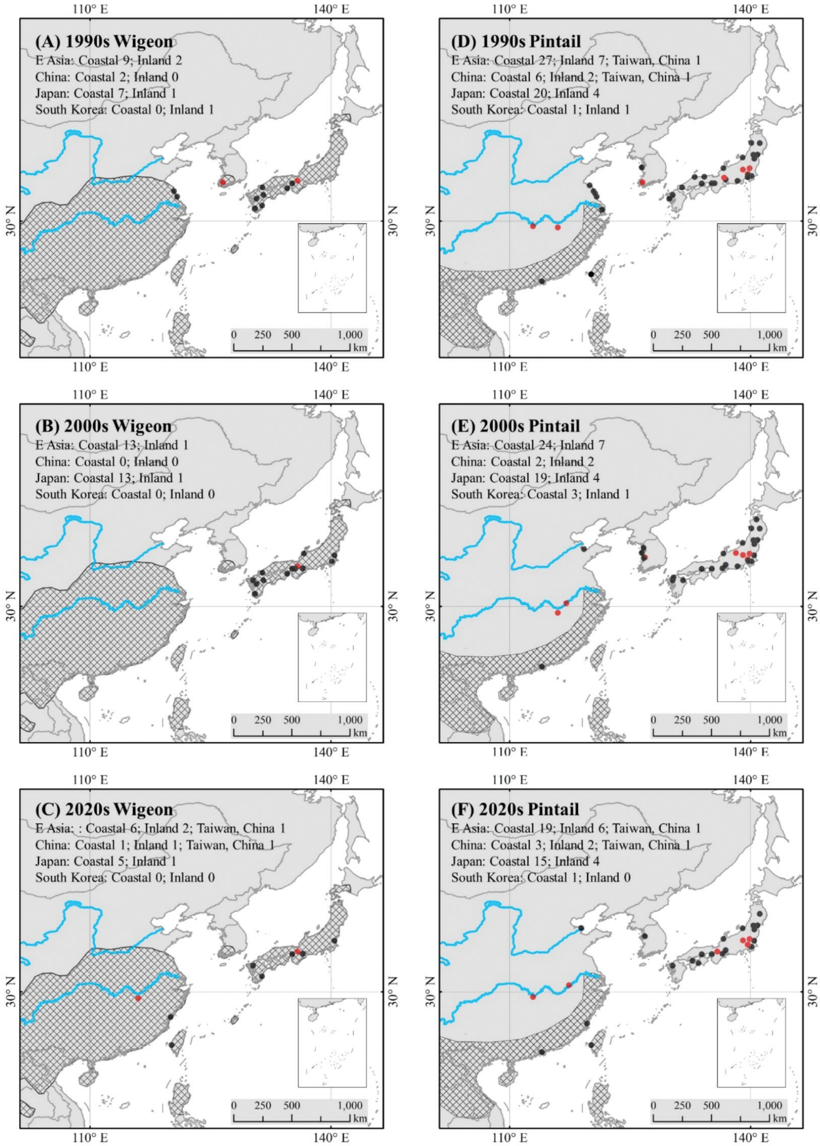


Figure 3. Changes in the number and distribution of Wigeon and Pintail at internationally important wintering sites in East Asia (≥ 1% of the total East Asian population, Wigeon = 7,100, Pintail = 2,400). (A) Internationally important wintering sites of Wigeon in East Asia in the 1990s, (B) 2000s, (C) 2020s; (D) Internationally important wintering sites of Pintail in East Asia in the 1990s, (E) 2000s and (F) 2020s. The black cross-hatched area represents the extent of the overwintering range according to BirdLife International (2017, 2019). Black dots = coastal internationally important sites; red dots = inland internationally important sites.

Table 3. Number of internationally important wintering sites identified in China, Japan and South Korea during the 1990s, 2000s and 2020s for Wigeon and Pintail (based on 1% thresholds of 7,100 and 2,400 respectively).

Species	Period	China	Japan	South Korea	Total
Wigeon	1990s	2	8	1	**11**
Wigeon	2000s	0	14	0	**14**
Wigeon	2020s	3	6	0	**9**
Total		**5**	**15**	**1**	**21**
Pintail	1990s	9	24	2	**35**
Pintail	2000s	4	23	4	**31**
Pintail	2020s	6	19	1	**26**
Total		**14**	**33**	**6**	**53**

Japan was the largest (6–14), concentrated in southern Japan, including 5–13 internationally important wintering sites in coastal areas. Only Hyogo has remained important throughout, while other coastal internationally important wintering sites varied greatly. The only inland internationally important site for Wigeon in Japan is at Shiga. China has supported up to three internationally important wintering sites over three decades (1990s to 2020s), with two coastal sites on the southern Jiangsu coast (Sheyang Saltworks and Dafeng Port-Jiang Port), but these had lost their international significance by the 2000s. Three new internationally important wintering sites appeared in the 2020s (two coastal: Funing Bay, Taiwan and the Yellow River estuary and its south; and one inland, at Poyang Lake in the Yangtze River, Figs. S2 & S3, Tables S10, S11 & S12). In the 1990s, South Korea had only one internationally important wintering site, along the Lower Yeongsan River (inland), which no longer supports internationally important numbers. At present, seven of the nine internationally important sites are concentrated in coastal area (mainly in southern Japan, coastal Fujian, and Taiwan) and two inland (Yangtze River basin in China; Shiga in Japan) (Fig. 3, Table 3, Table S9).

Along the EAAF, the internationally important wintering sites for Pintail were mainly confined to East Asia, and only one internationally important wintering site was found in Southeast Asia in 2000 (6,665 in Myanmar). There are 35 (24 in Japan, nine in China and two in South Korea), 31 (23 in Japan, four in China and four in South Korea) and 26 (19 in Japan, six in China and one in South Korea) internationally important wintering sites in

East Asia in the 1990s, 2000s and 2020s, respectively.

In 30 years, most internationally important wintering sites for Pintail along the EAAF were in coastal areas (19–27 sites), while a few were in inland areas (6–7). Japan had the largest number of internationally important wintering sites (16–24). Fourteen sites were consistently important, concentrated in the southern region of Hokkaido. Of these, three are inland (Saitama, Gunma and Tochigi), and 11 are coastal (Aichi, Okayama, Chiba, Yamagata, Fukushima, Niigata, Saga, Hyogo, Ishikawa, Iwate and Miyagi). China had the second greatest number of internationally important sites (4–9), with nine in the 1990s (Jiangsu coastal: Sheyang Saltworks, Xinyang Port-Dafeng Port, Dafeng Port-Jiang Port and Guandong Saltworks; Shanghai: Baoshan Tideland; Deep Bay in Hong Kong; Taiwan; Inland: Poyang Lake and East Dongting Lake in the Yangtze River), four in the 2000s (Shandong coastal: Laizhou Wan; Deep Bay in Hong Kong; Inland: Poyang Lake and Shengjin Lake on the Yangtze River) but six in the 2020s (Shandong coastal: Huang He NNR; Fujian: Minjiang Kou; Deep Bay in Hong Kong; Taiwan; Inland: Dongting Lake and Baidang Lake on the Yangtze River, Fig. S2, Tables S10, S11 & S13). The inland site qualifying as internationally important for wintering Pintail in South Korea in the 1990s was in the Lower Yeongsan River, and that in the 2000s was the Lower Geum River, but neither qualified in the 2020s. The number of internationally important coastal wintering sites increased from one in the 1990s (Ganwol Reservoir) to three in the 2000s (Shihwa Reservoir, Ganwol Reservoir and Geum River Estuary) but fell back to a single site in the 2020s (Asan Bay). The internationally important wintering sites are located between 40°N (south of Hokkaido, Japan) and 22°N (Hong Kong, China). Currently, 20 of the 26 internationally important sites are concentrated along the coast (the coast south of Hokkaido, Japan; Shandong coast, Fujian Coast, Hong Kong and Taiwan in China; Asan Bay in South Korea) and six are inland (the Yangtze River in China; south of Hokkaido in Japan) (Fig. 3, Table 3, Table S9).

Shifts of coastal and inland wintering ducks in East Asia

In the 2020s, 73% and 27% of all East Asian Wigeon was found along the coast and inland, respectively. For 30 years, along the coast, the Korean population has been small, while the Japanese population has been stable, and the East Asian coastal population has declined by more than 70% due to the apparent loss of some 450,000 wintering along the coast of Jiangsu, China (Table S14). Despite the decline in South Korea, the total numbers wintering inland in East Asia rose by 19%, due mainly to shifts in China and Japan (Table 4).

In the 2020s, 87% and 13% of an estimated 189,400 Pintail were found along the coast and inland, respectively. For 30 years, along the coast, wintering numbers in South Korea have been low and relatively stable, or rising slightly in Japan, but coastal China's population fell by about 257,000, contributing to an overall decline of more than 57% in East Asia. Numbers counted inland in China, Japan and South Korea

Table 4. Changes in the numbers and proportions of Wigeon and Pintail counted in coastal areas of China, Japan and South Korea during the three periods.

Area	**Period**	**Wigeon**				**Pintail**			
		Inland %[a]	**Coastal %[b]**	**Inland**	**Coastal**	**Inland %[a]**	**Coastal %[b]**	**Inland**	**Coastal**
Chinese mainland	1990s	4%	73%	26,300	473,700	30%	42%	210,700	289,300
	2000s	6%	15%	14,000	36,000	8%	11%	18,400	27,600
	2020s	16%	18%	37,700	44,300	7%	15%	14,600	32,400
Japan	1990s	3%	17%	16,500	110,200	4%	20%	28,700	140,200
	2000s	11%	66%	25,600	156,800	8%	64%	19,400	156,400
	2020s	11%	52%	27,700	126,400	6%	70%	13,200	152,100
South Korea	1990s	2%	1%	12,800	7,600	2%	2%	10,800	11,700
	2000s	1%	2%	1,500	5,100	3%	6%	7,200	15,200
	2020s	0%	2%	600	4,600	1%	2%	1,500	4,900
East Asia[c]	1990s	9%	91%	55,600	591,500	36%	64%	250,200	441,200
	2000s	17%	83%	41,100	197,900	18%	82%	45,000	199,200
	2020s	27%	73%	66,000	175,300	13%	87%	29,300	189,400
Total for East Asia[c]	1990s		**647,100**				**691,400**		
	2000s		**239,000**				**244,200**		
	2000s		**241,300**				**218,700**		

[a]The number of China, Japan, Korea and inland areas in East Asia as a percentage of total East Asia.
[b]The number of China, Japan, Korea and coastal areas in East Asia as a percentage of total East Asia.
[b]The total number in East Asia (inland and coastal combined) for each time period.

have all declined over the 30 years, contributing to the overall 88% decline in East Asia (Table 4).

Discussion

Population size and distribution trends of Wigeon and Pintail along the EAAF

This analysis represents the first systematic evaluation of the status and distribution of Wigeon and Pintail along the EAAF in 30 years, resulting in new biogeographical sub-population estimates, which are substantially lower now than at the beginning of the period. The WPE3 (2002) estimated a total of 750,000 Wigeon in the EAAF, based on 670,000 in East Asia (500,000 in China; 10,000 in South Korea; 160,000 in Japan) and 80,000 in Southeast Asia (Miyabayashi & Mundkur 1999). Each of the subsequent three Waterbird Population Estimate reports (WPE5, WPE4 and CSR1) quoted Miyabayashi & Mundkur (1999) as their source for maintaining similar levels for subsequent population estimates, but only WPE5 (2012) adjusted the estimate downwards to 710,000. Based on the data presented here, the estimate of the numbers of Wigeon in East Asia in the 1990s was actually similar to that of WPE3, but in reality, it seems that there were only 1,000 individuals in Southeast Asia instead of the predicted 80,000 at that time. Current data sources suggest that numbers in East Asia in the 2000s amounted to 240,000, with 800 in Southeast Asia, which compares with an estimated 250,000 in East Asia and 100 in Southeast Asia in the 2020s. As a result, the current estimate is ostensibly 500,000 fewer than 30 years ago, mainly due to a decline of about 400,000 in China, and the 80,000 fewer in Southeast Asia. On this basis, we would recommend that Wetlands International undertake an evidence-based revision of the flyway estimate for this sub-population of Wigeon, given this new and historical knowledge.

Based on data from Miyabayashi & Mundkur (1999), the WPE3 (Wetlands International 2002) estimated the population size for EAAF Pintail at 750,000, including about 720,000 in East Asia (500,000 in China; 15,000–30,000 in South Korea; 190,000 in Japan) together with more than 30,000 that were estimated in Southeast Asia (although reliable figures for these are lacking). Following that, WPE4 (Wetlands International 2007) adjusted the population estimate to 250,000 (specifically adjusting the estimate for China to 10,000) according to Barter *et al.* (2004). The population size estimate notes for both WPE5 (Wetlands International 2012) and CSR1 (Mundkur & Langendoen 2022) reports refer to WPE4 as source, but are further adjusted to 240,000 in total. The data trail we present here again suggests the need for a re-evaluation and revision of the current estimate based on the original WPE3 (Wetlands International 2002) estimate, to explain the reason for the missing 500,000 gap in Pintail numbers over the 30 year period.

It is evident from the data presented here that the estimate for numbers of Pintail wintering in East and Southeast Asia in the 1990s was less than presented in WPE3 (Wetlands International 2002). This could be due to a combination of potential real declines and overestimations of the

Chinese wintering numbers (put at 500,000 in the 1990s) with discrepancies and methodological issues in Southeast Asia, where available counts at that time suggested that there were only 1,400, not the 30,000 estimated. In the 2000s, numbers in East Asia were assessed to be around 250,000, and Southeast Asia at 4,100, compared with 220,000 in East Asia and 500 in Southeast Asia in the 2020s. Our current estimates are therefore 500,000 fewer than 30 years ago, mainly due to a discrepancy of hundreds of thousands in China, and of 20,000 in Southeast Asia. The current Pintail population estimate in CSR1 (Mundkur & Langendoen 2022) is similar to the results of this study, but we propose revision of the Chinese estimate of Pintail upwards to 52,000 (the estimate in WPE4 was 10,000), comprising 47,000 in mainland China and 4,900 in Taiwan.

Over the past 30 years, numbers of Wigeon and Pintail have increased until the end of the 2000s followed by a period of stabilisation or slight decline in Japan, while lesser numbers wintering in Korea have consistently declined since the 1990s. In China, numbers appear to have dramatically declined between the 1990s and 2000s, but have stabilised since. Although potentially difficult in the absence of direct evidence, it remains a priority to understand the causes for these losses in order to strengthen wetland restoration and protection in China and South Korea, for the effective conservation of these two important dabbling duck species. Other factors also need urgent research attention (*e.g.* avian influenza, hunting and wetland degredation in other countries), which pose a threat not only to Wigeon and Pintail but also to a range of other waterbirds.

Assessing quality of the monitoring data

Waterbird estimates for China in the 1990s were compiled based on data from 58 wetlands reported by the Water Bird Group of the Chinese Ornithological Society (1994; Table S15). At that time, the area of wetlands in China was known to be 1.16 times larger than in the 2000s (Peng 2010). In retrospect, important areas holding denser contrations of birds within the larger wetlands were more difficult to access for observers at that time. Transport and track and road infrastructure was poorer (Hu & Zhao 2018), survey funding was very much more limited, optical equipment was of far less quality and survey coverage generally very restricted compared with today. All these factors suggest that the number of ducks counted in the 1990s may have represented ≤ 10% of the true number of ducks present in those years. There can be little doubt that there were spectacularly more dabbling ducks in China in the 1990s than there are now, but it is unlikely we shall ever know the true numbers present.

In the 2000s, estimates in China were based on a systematic survey of 134 coastal and inland sites carried out by the Chinese Academy of Sciences (Cao *et al.* 2008), who recorded count coverage at all observation points throughout all surveyed wetlands. The estimates for China in the 2020s are also conducted by the Chinese Academy of Sciences, continuing and building upon the earlier work (Jia *et al.* 2016; Ao *et al.* 2020a, b; Damba *et al.* 2020; Deng *et al.* 2020; Fang *et al.* 2020; Li *et al.* 2020a; Sawa *et al.* 2020; Yan *et al.* 2020), while the marine habitats formed part of the systematic investigations of the Coastal Waterbird Synchronous Survey Team (Table S4; Choi *et al.* 2012). Although the number of surveyed sites decreased from 52 to 33 during the survey period (Table S15), many other coastal areas suffered serious lost due to land claim (up to 80% in some areas, Xu *et al.* 2019). Therefore, the percentage of surveyed wetlands in the total number of suitable duck habitats in eastern China was still 80%, the same as in the 2000s. In summary, while it is probably difficult to compare the count data from China in the 1990s with the later years, we consider the abundance estimates for Wigeon and Pintail in China from the 2000s and 2020s are relatively robust as a basis for comparisons between these two periods.

In East Asia, data submitted by countries in the AWC for 1997–2015 were collected annually (Li & Mundkur 2004, 2007; Mundkur *et al.* 2017), although reporting for three of the 19 years (2005–2007) was not publicly available. China, Japan and South Korea submitted 16 annual reports, although Taiwan is missing five reports and North Korea has never submitted a report. In terms of the total number of survey sites, Japan (1,820) and South Korea (1,924) were highest, followed by China (278). The AWC has not published data for the period 2016–2021, but an online review of the status of the populations of these two species provides a 6-year record of maximum value for four countries (Wetland International 2023), including the first ever survey of North Korea in the 2020s. Japan and South Korea have established and maintained an excellent monitoring system since the 1990s, but China and North Korea need to improve, especially North Korea, which needs to establish a monitoring and reporting system and comply with international agreements to protect migratory birds. Data from Japan and South Korea during the three periods come from a systematic annual monitoring system, and the abundance estimates for China over the past 20 years are also based on a systematic survey, which is providing increasingly accurate estimates. However, as long as we lack data from North Korea, East Asia estimates will be modest underestimates.

In Southeast Asia, of the 11 countries with wintering waterbirds, Laos and Timor-Leste submitted only one report, while the other nine countries each submitted 11–16 reports (Li & Mundkur 2007; Mundkur *et al.* 2017). The medium-sized countries (5 million to 500,000 km^2) of the Philippines (1,701 sites counted), Indonesia (283) and Myanmar (256) covered many sites, as did the smaller countries (< 500,000 km^2) such as Thailand (545 sites counted), Malaysia (303), Singapore (132), Cambodia (120) and Brunei (113) which typically report data from 110–550 sites, but three countries, Vietnam (48), Laos (1) and Timor-Leste (1), all fall below 50 sites each. The Philippines, Thailand, Malaysia, Indonesia, Myanmar, Singapore, Cambodia and Brunei have all established national surveillance systems and submitted regular reports since 1997, so the data are therefore more systematic, while Vietnam needs to increase the number of monitoring sites, and North Korea, Laos and Timor-Leste need to establish waterbird monitoring and reporting systems. Nevertheless, based on all these monitoring schemes, it is clear that the abundance of both species is extremely low in Southeast Asia; for instance, only four Pintails were found in Laos in 2000.

Distribution of Wigeon and Pintail along the EAAF

Over the last 30 years, as well as demonstrating the outstanding importance of China, Japan and South Korea for wintering Wigeon and Pintail, the data presented here confirm the general lack of large numbers of wintering individuals of both species elsewhere in East and Southeast Asia, despite earlier suspicions that this was the case. North Korea provided maximum counts during 2016–2021 of 756 Wigeon and 218 Pintail (Wetland International 2023a) and, while it is not clear how reflective this is of true numbers present, most of the country lies north of the zero degree January isotherm and is therefore not likely to hold large numbers of either species which favour wintering temperature between 4° and 8°C (Dalby *et al.* 2013). There were 1,400 Wigeon and 761 Pintail reported from 16 sites surveyed in Vietnam in 2002, the number of surveyed sites was the highest (16 sites), and recorded four Pintail in Laos and none in Timor-Leste with only one annual report (Table S8).

This paper confirmed that the distribution of both species of duck extend to five Southeast Asian countries (Myanmar, the Philippines, Thailand, Vietnam and Laos), consistent with Birdlife's map (Wetlands International 2023b), albeit in small numbers (1% of Wigeon; 2% Pintail). In the remaining six countries (Cambodia, Brunei, Myanmar, Singapore, Indonesia and Timor-Leste) count numbers returned indicated no birds, suggesting that currently these countries do not support large numbers of either species. However, that is not to say there could not remain major unknown aggregations of Wigeon and Pintail in the region and this would bear more survey in these countries.

For these reasons, we conclude that it would be a useful exercise for Wetlands International to review the biogeographic sub-populations abundance, status and distribution of East Asian Wigeon and Pintail in relation to improving future monitoring (*e.g.* strengthen regular monitoring efforts in North Korea) and their overall population estimates.

Internationally important sites and changes of two duck species along EAAF

At present, the distribution of the nine internationally important wintering sites for Wigeon lie between 36°N and 22°N and represent a southward expansion compared with earlier years (Fig. 3). In a period of climate change, we might predict wintering waterbirds to respond to warmer winter conditions (which enable areas of open water to persist further north, Li *et al.* 2022), by moving their ranges northwards (Lehikoinen *et al.* 2013), including species such as the Tundra Bean Goose *Anser fabalis serrirostris* which is responding to climate change in East Asia (Meng *et al.* 2022). However, in contrast, the 26 internationally important wintering sites for Pintail were similarly in the 40°N–22°N range, which seems not to have changed radically over the study period.

The number of inland sites qualifying as internationally important for the two duck species (Wigeon 1–2, Pintail 1–7) were much fewer than those on the coast (Wigeon 6–13, Pintail 19–27). Although both species use coastal habitats, their inland internationally important sites still need to be protected to avoid overconcentration in coastal areas and to prevent large-scale population reduction caused by coastal reclamation. For example, severe reclamation along the coast of Jiangsu (Zhang *et al.* 2013) led to a significant decline in the numbers of Wigeon and Pintail wintering in the region after the 1990s (declines of *c.* 450,000 and 120,000 respectively), resulting in the disappearance of internationally important sites in the region, and contributing to the explanation for the total East Asian population in the 2020s being only 29–32% of that of 30 years ago.

The future

Long distance migratory waterbirds are threatened by a multitude of environmental pressures (such as habitat loss, climate change and overexploitation) that affect their suvival and reproduction. Our only means of understanding how these pressures affect discrete biogeographical populations of such waterbirds is to systematically monitor their distribution and abundance over sustained periods. As this analysis shows, we are beginning to be in a position to do such analyses for selected ducks in the EAAF, thanks to the foresight of previous researchers, but to differentiate shifts in range and habitat from changes in overall abundance necessitates coordinated international systematic monitoring programmes to deliver more robust population estimates and trends. In this regard, it is recommended that a simultaneous internationally coordinated survey of waterbirds at least in January every year should be carried out across the wintering distribution of both these duck species, but embracing all waterbirds, especially in China, Japan and the Korean Peninsula. For areas with fewer wintering numbers of both duck species, such as Laos and Timor-Leste in Southeast Asia, currently lacking such annual coverage, we recommend one-off winter surveys be planned every five years to determine the wintering waterbirds of these countries, with a view to contributing such data to the AWC and the longer aim of establishing national bird monitoring systems. We would also recommend telemetry studies of Wigeon and Pintail to quickly map the nature and structure of their different migration routes in East Asia, to further refine our definition of biogeographical sub-populations, as well as providing insight into habitat use, important areas throughout the annual cycle and mortality. We also see great potential in strengthening the protection of both species in China and South Korea, especially via habitat protection in the coastal areas of China and Asan Bay in South Korea. However, this should not be achieved at the cost of continued monitoring of the two species at inland wintering sites throughout the region, including the need for gap-filling surveys to confirm the extent of coverage and the effectiveness of current monitoring programmes to determine their effectiveness.

Conclusion

For 30 years, more than 98% of Wigeon and Pintail along the EAAF were distributed in East Asia, with only small numbers in Southeast Asia. The two species are mostly distributed in coastal areas, and their estimated numbers wintering in East Asia are currently 250,000 and 220,000, respectively. The difference between the new estimates and that of WPE3 for Wigeon is 500,000, mainly due to an apparent loss of about 400,000 in China and 30,000–80,000 in Southeast Asia. Pintail have not shown such major changes in over flyway population size. The estimates of both species in this flyway should therefore be examined and revised. Overall numbers of both duck species in East Asia showed a downward trend, of which the numbers in Japan were stable or rising, while the numbers in China and South Korea showed a downward trend, especially the numbers in the coastal areas of Jiangsu Province in China. Urgent research attention is required to better understand the precise causes for these declines and to strengthen ongoing wetland protection initiatives, mostly in China and South Korea, but throughout the flyway used during the full annual cycle, to effectively protect Wigeon and Pintail in the Far East.

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Photograph: Northern Pintail upending, by Daniele Occhiato.