Population and range fluctuations of Asian Dowitcher *Limnodromus semipalmatus* in the central Asian arid zone

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The main breeding range of the Asian Dowitcher *Limnodromus semipalmatus* lies within the limits of the arid zone in south-western Siberia, Mongolia and China. Further north, up to 56-57°N, it is patchily distributed on isolated areas of relict steppe. At the end of the 19th century several hundred pairs were known to be breeding at the northern limits of the species' breeding range. Their population during this period was probably stable. Since the mid-1970s the population has increased to 6,000 birds. This is mainly due to extreme droughts in the southern parts of the breeding range and an expansion of at least 1,000 km in the extent of the northern boundary. This increase occured very rapidly over a period of about two years. The subsequent population decrease was slow, lasting more than ten years. Currently (1990-1991) the population is similar to that at the beginning of the century. A slow decrease in numbers in the northern part of the breeding range after the drought ended in the south indicates that the species is both highly site-faithful and very mobile. The species' expansion is characterised by marked irruptions during extreme droughts, their scale depending on the size of the areas suffering from drought. This behaviour is a characteristic adaptation to existence in arid regions.

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Основной гнездовой ареал азиатского бекасовидного веретенника *Limnodromus semipalmatus* расположен в пределах аридной зоны на юге Западной Сибири, в Монголии и Китае. Севернее этого региона, до 56-57° с.ш., вид распространен неравномерно на изолированных участках реликтовой степи. Известно, что в конце 19-ого века несколько сотен пар гнездились у северных границ гнездового ареала. Численность в этот же период была, вероятно, стабильна. С середины 70-х годов текущего столетия популяция возросла до 6,000 особей. Это произошло прежде всего вследствие как чрезвычайно сильных засух в южных районах области гнездования, так и расширения границ ареала по крайней мере на 1,000 км в северном направлении. Рост численности произошел очень быстро, в течение около двух лет. Последующий спад численности был медленным и длился свыше десяти лет. В настоящее время (1990-1991) численность популяции сходна с численностью в начале века. Медленный спад численности в северной части ареала после прекращения засухи в южных районах указывает на то, что виду свойственна высокая степень как гнездового консерватизма, так и подвижности. Расширение ареала вида характеризуется заметными налетами во время сильных засух, при этом масштаб налетов зависит от площади районов, страдающих от засухи. Такое поведение - характерное приспособление к выживанию в аридных регионах.

Introduction

Publications from recent decades have shown that the spatial structure of the ranges of waders such as Avocet *Recurvirostra avosetta*, Black-winged Stilt *Himantopus himantopus*, Marsh Sandpiper *Tringa stagnatilis* and Asian Dowitcher *Limnodromus semipalmatus* breeding near the water bodies of the arid zone of Central Asia are very variable (Melnikov 1986a, 1986b; Osipova 1986). As the arid zone only extends into Russia at the border, the characteristics of this phenomenon could only be studied for the northern boundaries of the waders breeding in these arid areas. The group of waders that use the narrow habitat spectrum in the arid region are of special interest, as most of them are included in the Russian Red Data Book's regional lists of endangered species and thus require special measures for their protection. An important element of such work is the analysis of those

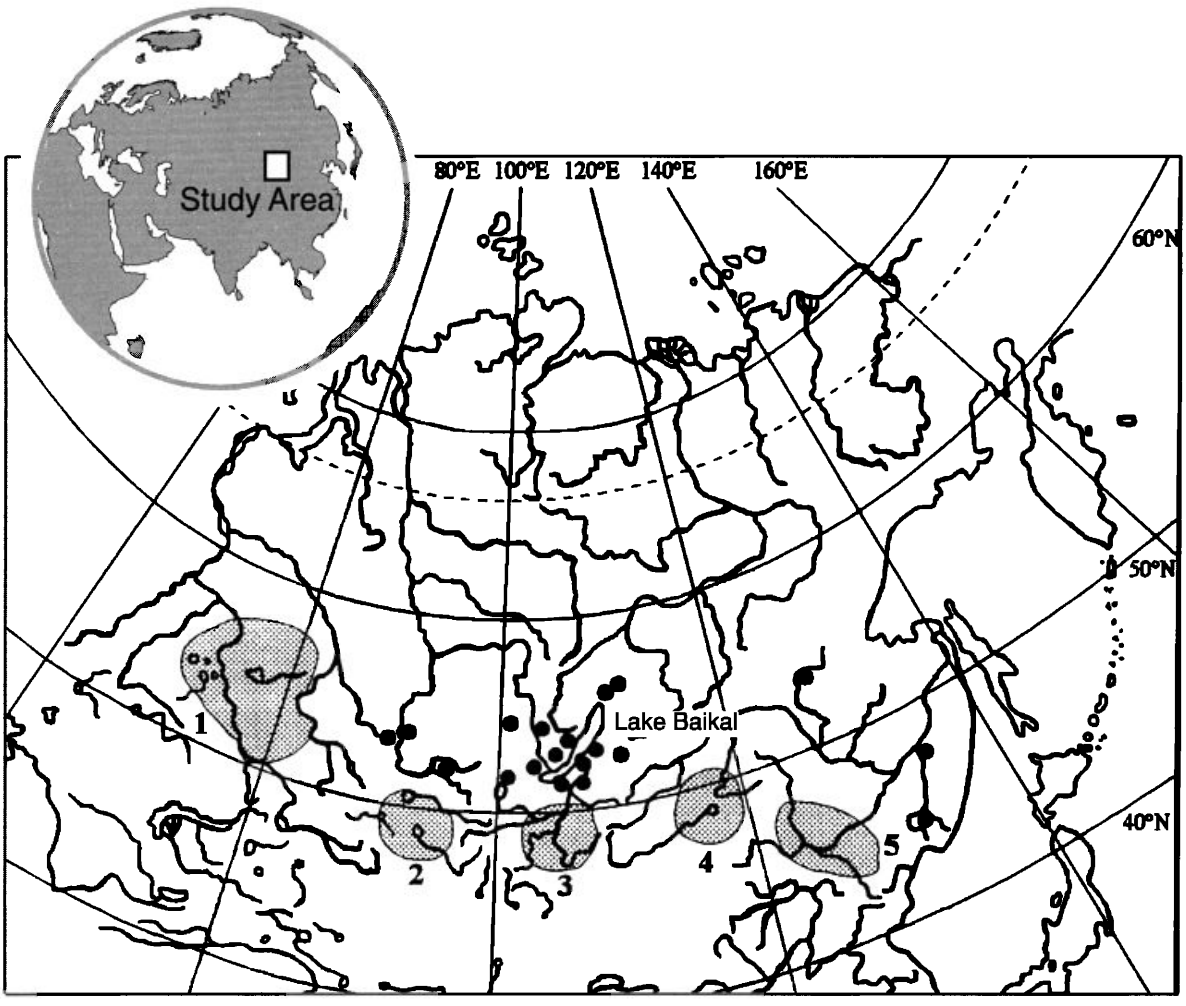

Figure 1. Asian Dowitcher breeding range: 1 - West Siberian concentration; 2 - the Large Lakes depression (Mongolia); 3 - Selenga river basin concentration (Mongolia); 4 - Russian-Mongolian-Chinese concentration; 5 - Cicikar concentration (China); ● - records of Asian Dowitchers during invasions to northern range limits.

population processes for species of which only limited data exist. The Asian Dowitcher is used as an example of this analysis of fluctuations in numbers and changes in breeding range boundaries.

The Asian Dowitcher is a rare, poorly studied wader species, included in the IUCN Red Data Book and in the Red Data Books of several countries within the CIS. The total population was estimated not long ago at 1,000 birds. Surveys at the wintering grounds in south-eastern Asia made it possible to update this figure to 5,000 birds in 1984. After a further inventory of the wintering grounds in 1989, the population was estimated at 15,000 - 20,000 birds (Howes & Parish 1989). Surveys made within its breeding range in Russia in years when large numbers of birds were present estimated less than half this number (less than 6,000 birds; Melnikov 1986a), whilst the data from other parts of the breeding range are insufficient for even a preliminary estimate of population size.

Methods

Information presented in this paper is based on 20 years of studies from 1972-1991. During this period we collected data on the changes in numbers of this species in south-eastern Siberia, as well as detailed information on the ecology of Asian Dowitcher at the Selenga river delta (1973-1980) and the Irkut river mouth (1983-1987). The most probable breeding areas were also surveyed (Melnikov 1985, 1986a, 1991), and all published data were analysed. Total counts were made at the Selenga delta once every two or three years using specially designed methods (Melnikov 1986c). Reproductive success was estimated according to Mayfield (1975), modified by Payevsky (1985). The nest-histories of a total of 625 nests were recorded: 531 nests at the Selenga delta and 94 at the Irkut river mouth.

Results and Discussion

The breeding range occupies a narrow belt in the forest-steppes, steppes and semi-deserts from south-western Siberia across the Baikal regions, Mongolia, and northern China to the shores of the Primorye Territory. The main part of the breeding range is situated within the arid zone, where birds inhabit extremely variable wetland ecosystems. The characteristic distribution is due to the fact that they choose to breed in rather flat, swampy meadows with low grass cover, which often have numerous

shallow temporary water bodies, as well as the shallow waters and mudflats of temporary lakes in the steppe areas. Most of the records from the northern boundary of the breeding range have been in areas of steppe or similar habitats. Judging from published data (Pevtsov 1883; Kozlova 1930) the same is true also for the southern boundary of the species' breeding range.

The most characteristic feature of such arid areas is the sharp cyclic fluctuations of water level in lakes and other water bodies (Shnitnikov 1957; Maksimov 1984; Melnikov 1986b; Krivenko 1991). Such cyclic changes in the watertable affect breeding conditions for shorebirds and waterfowl. Consequently the existence of locations where breeding is always possible, only occurs in vast swampy areas which have optimal habitat diversity (Melnikov, 1986b). The distribution of such areas is determined by landscape conditions and, as a result, they are situated well apart from each other. In between are rather small swampy areas which can support only a few breeding Asian Dowitchers, often only in very favourable years (Figure 1).

One of these breeding concentrations is situated in the south-west Siberian lowland. This area is well isolated from the eastern parts of the species' breeding range, a fact reflected both in the migration routes of these birds and the position of their wintering grounds in north-east Africa and, probably, the Near East (Liedel 1982; Melnikov 1990). Although we do not reject the possibility that birds from Mongolia can penetrate to Western Siberia, especially in big expansion years, we consider this breeding population to be separate and well-isolated from the main part of the breeding range and restricted to Russia. The relatively small population, which comprises less than 1.0% of the world population of Asian Dowitchers, means that special conservation measures are extremely important in Russia (Melnikov 1990).

Two large breeding concentrations are situated in northern Mongolia: at the Large Lakes depressions, from where birds penetrate to Tuva Republic and the Minusinsk depression, and at the Selenga river basin. The last one is the most significant breeding concentration, from which Dowitchers spread in unfavourable years to areas close to the southern and south-western Baikal Lake areas (Melnikov 1991). At Hubsugul Lake the birds appear sporadically, probably penetrating from the Large Lakes depression or from the Selenga river basin. Another breeding concentration is located at the borders of north-eastern Mongolia, southern Russia (Dauria) and north-western China (Barga), and includes the Dalai-Nor, Byi-Nor and the Toreiskiye Lakes and the basins of discharging rivers, as well as the middle reaches of the Argun river. The groups of Asian Dowitchers which sometimes appear at the Eravna Lakes, in the Barguzin and the Verkhnyaya Angara river basins probably originate from this Mongolian-Russian-Chinese breeding area.

One large concentration where breeding occurs regularly is situated in the Nonni and the Sunkhuaztsyan river basins and probably at the Sungari river basin, from where birds spread to Khanka Lake and the Zeya water reservoir. This breeding concentration is probably connected with the previous one as the rather low Kingan mountain range probably does not act as a barrier.
Available data (Taczanowski 1873; Velizhanin & Velizhanin 1929; Zalessky 1934) suggest that several hundred birds bred at the northern limits of the species' range (in Russia) in the late 19th - early 20th centuries. The species was considered to be extremely rare and probably going extinct. Sometimes, according to these observations, the numbers of Asian Dowitcher would fluctuate, although the data for that period are insufficient even for a general analysis. The appearance of the species in rather large numbers there during the 1970s was rather unexpected (Melnikov 1979; Gluschenko & Shibnev 1979; Yurlov 1981). According to maximum estimates made in different areas in the north of the breeding range, numbers of Asian Dowitchers at that time reached 6,000 birds (Melnikov 1986a). Since then the number of breeding birds has decreased and currently fluctuates from 700 to 1,000 - 2,000 individuals. The largest number, about 4,500 birds, was recorded at the Selenga Delta (Melnikov 1979, 1985).

The changes in numbers and in the structure of the Asian Dowitcher's breeding range are rather complicated and are determined by geographic and climatic conditions. As the latter change cyclically, it is possible that they influence breeding success. In this situation we can assume that the biggest differences in breeding success would be recognised at the beginning and end of a climatic hydrological cycle. Our data shows the tendency towards increasing breeding success during a hydrological cycle at the Selenga river delta, and a simultaneous decrease at the Irkut river mouth (Figure 2). Unfortunately, the regressions were not significant due to a high degree of variation during the intermediate years of the cycle. Additional estimates of the distribution of breeding success using the iteration criterion (Zaks 1976) did not reveal a temporal trend and proved the random distribution of the extreme values, which were recorded three times at the Selenga Delta and once at the Irkut river mouth (Figure 2). Thus, we believe that breeding success is not clearly related to fluctuations in the hydrological regime.

Numbers of Asian Dowitcher are limited over the whole breeding range by similar factors, the most important of which are high rates of predation, fluctuations in the water supply, nest-trampling by cattle and other types of human influence (Gluschenko & Shibnev 1979; Yurlov 1981; Melnikov 1985, 1991). Although the intensity of these factors differs between years, the average breeding success remains rather stable (Figure 2). This appears to be a result of compensatory adaptations to the changing environment with large differences in

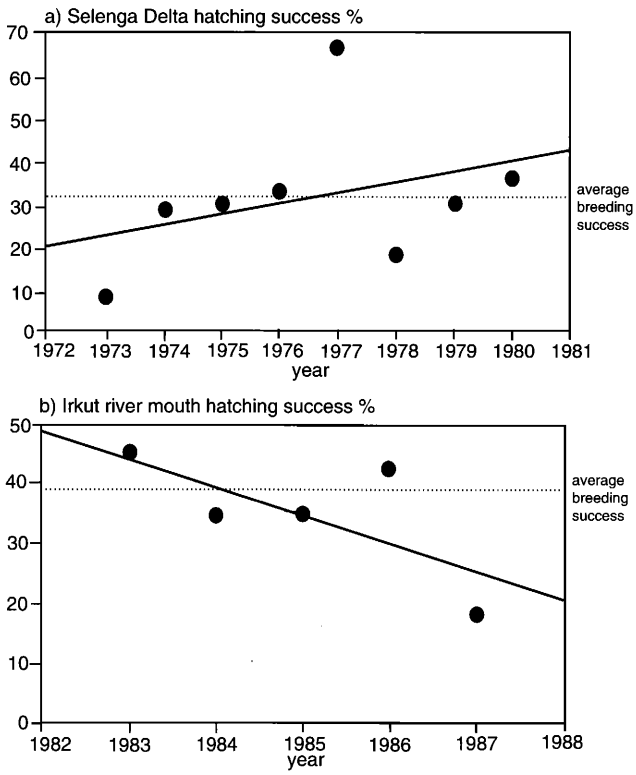

Figure 2. Variation in Asian Dowitcher breeding success a) in the Selenga Delta and b) in the Irkut river mouth during a complete hydrological cycle (from maximum to minimum water supply).

breeding success occuring only in years with extreme conditions (Melnikov 1982). Statistically significant differences in the breeding success of Asian Dowitchers ($p<0.01$) found at different study areas indicate geographic variations in population dynamics.

A sharp increase in the numbers of Asian Dowitcher could not be the result of changes in the relationship between local productivity and mortality rates. The breeding success of birds in the years before peak numbers remained at the usual average level (Figures 2 & 3). Although the population peak of 1977 coincided with very high breeding success, no increase in numbers was recorded in the following years (Figure 3). In addition, there was no correlation between numbers and reproductive success. The latter varied while numbers remained similar (Figure 4). There is no doubt that fluctuations in numbers at the northern limit of the species' range can be explained only by emigration and immigration processes, following from sharp environmental changes in the main part of the breeding range.

Our observations at the Selenga river delta and the Irkut river mouth demonstrate that the change in numbers was similar (Figure 3) during a mass appearance of Asian Dowitchers both in the cases of large-scale immigration and during local resettlement of birds. A sharp increase in numbers was observed over a period of one to two years followed by a decline to the original level. The prolonged decline in numbers to the lower level at the Selenga Delta was probably connected with comparatively high numbers during immigration. The slow decline in numbers observed during the next hydrological cycle indicates that two opposite trends exist within the population: high mobility but also some site fidelity. In spite of the restoration of suitable breeding conditions in the main breeding area, site fidelity was possibly the main reason for the slow decline in the numbers of Asian Dowitchers at the temporary, northern, breeding grounds.

Another peculiarity of the Asian Dowitcher is the formation of large local breeding concentrations, which can include up to 50% of the total population. Such concentrations were recorded at the Airik-Nor Lake (Pevtsov 1883), the Malyi Chan Lake in 1974 (Yurlov 1981), at the Selenga Delta in 1977-1978 (Melnikov 1979), at the Khanka Lake in 1975 (Gluschenko & Shibnev 1979), and at the Toreiskiye Lakes in 1971 (Shkatulova 1973) and in 1985 (Osipova 1986).

The breeding success of Asian Dowitchers even in such short-term concentrations can influence the size of the population over a fairly long period. Comparatively low average reproductive success (Figure 2), as well as some other characteristics of the species' ecology, suggest that the population remains stable or increases in periods to sharp increases in breeding success in single years (Figure 2). As the species has a rather long life expectancy and therefore a complicated age structure within the population, high productivity seasons maintain rather large and stable numbers over a long period

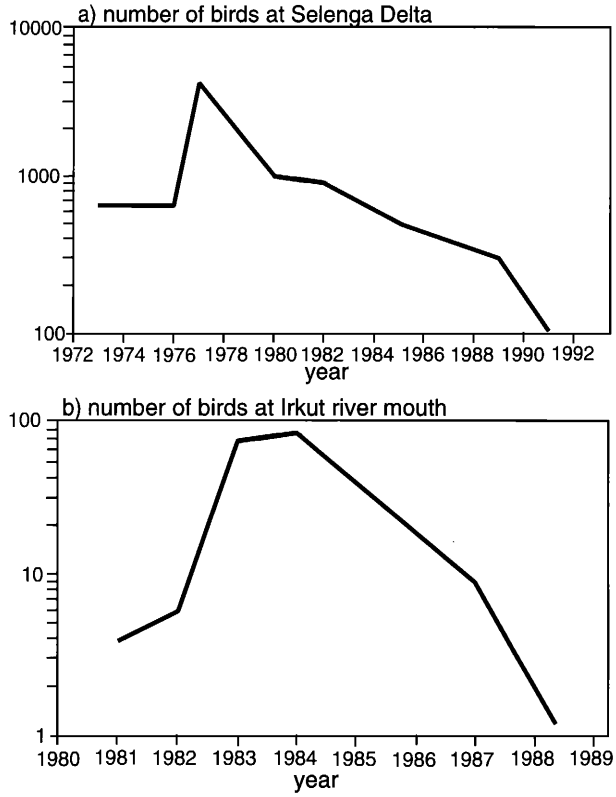

Figure 3. Changes in numbers of Asian Dowitchers a) in the Selenga Delta and b) in the Irkut river mouth in south-eastern Siberia. (Note log scale).

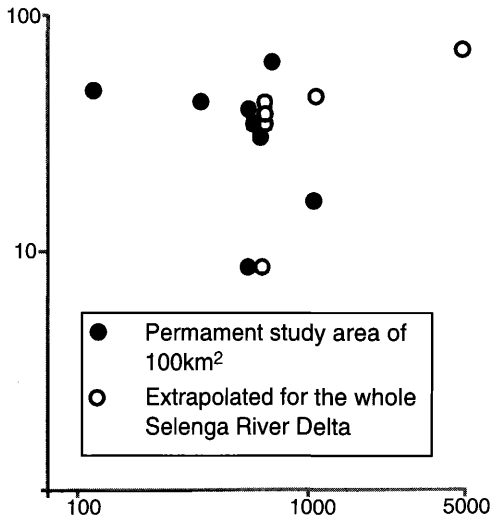

Figure 4. Relationship between the breeding success and numbers of Asian Dowitchers at the Selenga Delta. Note log scales.

of time. In other years reproduction only partly makes up for annual adult mortality and, as a result, the population declines until the next favourable breeding season. Obviously, when breeding success is extremely low, it can cause a significant decline in the population.

Our studies suggest that favourable breeding conditions occur once every eight to ten years (Figure 2). This is comparable to the average life of one generation, calculated by regression (Payevsky 1985), and also close to the length of one 11-year hydrological cycle.

Changes in numbers at the limits of the breeding range can be explained by cyclic changes in climate. Thus, the 20th century is characterised by a general warming of climate in the northern hemisphere (Budyko 1980), accompanied by increasingly frequent droughts, sometimes extreme ones. These droughts are observed asynchronously in different areas, passing gradually to the neighbouring regions (Pasechniuk *et al.* 1977; Rauner 1979; Koshelenko 1983). For example, the severe drought of 1968-1973 started in Africa and then moved eastwards, covering the large areas of India, Nepal, Burma, Sri Lanka and southern China. In 1972 it passed to more northern areas and spread over Europe and Central Asia (Koshelenko 1983).

In 1973-1974 the period of rather high humidity in south-western Siberia changed to a period of droughts, when large areas of the lake depressions within the range of Asian Dowitcher dried out (Maksimov 1984; Krivenko 1991). It was probably the main reason for the concentration of Asian Dowitchers from this part of the breeding range on the eastern shore of the Malyi Chan Lake, the Chulym and the Kargat river valleys, where the conditions for breeding had become optimal (Yurlov 1981). Since 1975, severe and prolonged droughts have occurred in China (Cheng 1978; Ofori-Sarpong 1980), and were at their worst when they spread to the neighbouring parts of Mongolia in 1977. As a result, in 1975 Asian Dowitcher was recorded in large numbers at Khanka Lake (Gluschenko & Shibnev 1979), and during the most severe droughts an influx was recorded at the Selenga river delta (Melnikov 1979; 1986a). So, the increase in numbers of Asian Dowitcher which was observed in Russia is connected with the large immigration of birds from the main breeding grounds which were suffering from severe droughts.

The connection between changes in the numbers of this species at the boundaries of its breeding range with the distribution and intensity of droughts at the main breeding grounds is emphasized by the mass appearence of Asian Dowitchers at the north of the breeding range at the same time as the droughts occur in the south (Melnikov 1986a). Although the wintering grounds of Asian Dowitchers from different breeding concentrations are at least partly shared (Verheugt *et al.* 1990), the asynchronous population fluctuations suggest that these concentrations are independent from each other.

An increase in rainfall in Russia usually coincides with droughts in neighbouring southern areas leading to the emigration of birds from the main breeding grounds. Although the optimal conditions for breeding Asian Dowitchers are found on early stages of ecological successions (Melnikov 1985; 1991), its mass appearence on the northern breeding areas does not always coincide with the formation of optimal breeding habitats. Thus we can conclude that emigration of Asian Dowitchers is determined only by environmental conditions at the main breeding grounds. The latter is proved also by the fact that, even in the extreme years, no more than half of the total population appears in the northern parts, while the rest evidently stay at the main breeding grounds, where suitable conditions remain locally.

Since it has been shown that breeding success in large, local concentrations of Asian Dowitchers formed during drought periods influences population level for a rather long period. We can suppose, judging by the results of winter counts (Howes & Parish 1989) that the most recent years have been rather favourable for this wader. It is quite probable though, that high population estimates for Asian Dowitcher on the wintering grounds were made in the years of the most successful breeding after the immigration of birds to northern breeding areas. At the same time we consider that the coincidence of unfavourable conditions for the species at different breeding concentrations over several years can cause catastrophic changes in the state of the Asian Dowitcher population.

The absence of mass emigration of Asian Dowitchers in the periods before and after the 1970s is explained by the absence of severe extensive droughts covering the main breeding grounds of the

species. It is known that such droughts last for two or three years and recur no more often than once in a century (Koshelenko 1983). We therefore suppose that the observed fluctuations in the number of birds also depends on such long-term cyclic climatic changes. Therefore we do not expect another mass appearence of the species at the northern breeding areas in Russia in the near future.

Conclusions

Long-term observations on Asian Dowitcher during a 20-year study and analysis of the literature demonstrate that the latest sharp increase in numbers of this species in Siberia was connected with the displacement of the optimal part of its breeding range to the northern areas due to emigration of birds from concentrations on the main breeding grounds. The scale of such emigrations are determined by the size of the area affected and the duration of the drought. Such a dynamic distribution is considered to be the main adaptation of Asian Dowitcher to dependance on wetlands in an arid zone environment. This adaptation is realized either through local redistribution of birds within breeding concentrations or through large-scale emigration, caused by sharp changes in the wetland ecosystems of the arid areas during long-term cyclic fluctuations in humidity. Even in periods of large-scale resettlement, only part of the Asian Dowitcher population appears in Russia. However, 6,000 birds recorded during the pre-breeding period in the Russian part of the breeding range represents about one third of the total world population of this species. The changes in numbers at the limits of the breeding range are completely determined by emigration and immigration processes.

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