

The impacts of climate change on migratory birds

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Abstract: Migration is very important for Migratory birds, which helps them to reproduce and expend extra energy in the body. However, there is an obvious trend that the bird population displays early migratory behaviour as the temperature keep increasing. In other words, birds are arriving at their breeding area at least 1 week earlier than 30 years ago, which was verified by different regions as well. This study discusses the impacts of global warming on the timing of the migration and the number of migratory bird globally. According to the results, the effect is not only on the early migration behaviour but also on the nesting time of the migratory population in Europe. In North America, the rising temperature affects the migratory timing of both long- and short-term migratory bird population. Moreover, most of the bird population shows advance in migration timing in Africa. Furthermore, the increase in global temperature has also impact on the number of migrations. The increase in energy need and the unpredictability of the food supply are the main controlling factors of the survival in the breeding area and reproduction of birds, and then affect the number of migrations. These results is important for people because a change in the migratory pattern of bird might finally leads to change in the whole ecosystem. So the early people getting know about it, the consequences might become less serious.

1. Introduction

Owing to the significantly increase of carbon emission in past century, the effects of climate change have become more obvious. Climate change is now a familiar topic for many people than it was in the past. Global warming, for example, is one of the serious phenomena that caused by climate change. The most obvious effect is that the summer is getting hotter while winter is getting colder. Additionally, it might lead to more serious effects, e.g., glacier melting and rising level. In more severe situation, the heat energy that caused by rising temperature will provide kinetic energy to the air and ocean. Moreover, it might form some large-scale disasters (e.g., typhoon, hurricane or tsunami), which might have significant impact of the security of coastal citizen [1].

Besides the impact of global warming on the environment, the climate change has a huge impact on organism as well. For example, the rising temperature will result in series of reactions, e.g., the glacier will start melting down and cause overall sea level rising, and the rising sea level might destroy some animals' habit [2]. The increasing temperature might cause some animal species unable to survival because of the destruction of their microclimate. Moreover, some species are experiencing change in their behavior as well.

Migratory bird, for instance, are affected by global warming significantly. Specifically, they are experiencing change of their migration period or lost of their habitats. For migratory birds, migration is very important, because migration can help them to reproduce and expend extra energy in the body. Previously, birds form migratory habitat because they need to move to warmer places, such as move to south, to get through cold environment. However, because of the environment is keep getting warmer nowadays, they display a phenomenon of change in migration timing.

Contemporarily, there are plenty of studies such as the decline of migratory birds and an assessment of potential causes and the influence of global warming on timing of migration and breeding of

migratory birds in twentieth century, related to this phenomenon, however, those are mostly focus on the changes happened in certain region. Combined with pervious studies, this study discusses the impact of climate change on the timing of migrating and number of migratory in a global scale.

2. The impacts of climate change on migratory time of migratory birds

2.1 Global effects

As the global temperature rises, the global birds have a tendency on earlier migration time in the twentieth and twenty-first century.

So far, there are alternations on migration time on birds all around the world. Overall, birds arrival in the 1980s and late 1990s was discovered markedly earlier than in the 1970s and part of the 1960s. In addition, judging from the average date of hatching and the date of first capture of juvenile birds in the study area, the timing of nesting in many birds varies from year to year to the same extent as the timing of birds migration as listed in Table1.

Table 1. Correlation between timing of spring migration of different migratory birds and monthly average air temperature (T, °C) (1959–2002) [3]

Species	Date of arrival	Temperature
Parus major	-0.03	0.56
P. caeruleus	-0.15	0.39
Fringilla coelebs	-0.46	0.69
Motacilla alba	-0.3	0.65
Hirundo rustica	-0.38	0.48
Hippolais icterina	-0.45	0.25
S. borin	-0.26	0.4

Data are from Advances in Ecological Research and there is an obvious trend that migratory birds are advancing their migratory time.

2.2 The impacts in different regions

Correlating with global rising temperature, birds in different regions show different patterns on bird migrations. Species in Europe, America and African have some main changes on their migrating times or behaviors due to the global warming.

2.2.1 Europe

The global warming affects not only the migratory time but also some birds nestling. This result was the same as other regions in Europe.

In Europe, it can be observed that long-distance migratory birds are more easily to be affected by global warming. More birds were captured during the 2001-2005 period compared to the 1987-1990 period in Spain. The distribution of both periods indicate that long-distance migrants have advanced their autumn migration due to the global morning. Mean week of migration for long-distance birds began at the beginning of the third week of September during the 1987-1990 period while the mean was at the end of the second week of September during the period 2001-2005. However, short-distance migrants didn't indicate significant differences at both periods. [4]

Moreover, the rising temperature can also affect migratory birds' nestling. During the longer period of analyzed on migratory birds in Poland, 78 species were analyzed about their nestlings as the temperature increases. The activity of these species strongly depends on the global warming. The decrease in the population size of Red-backed Shrikes in some regions of Europe was even illustrated by rising temperature during their breeding period. The losses of some kinds of species were affected by the number of hatched nestlings in all distinct periods of the nestling life. The reason is that some migratory birds (e.g., the Red-backed Shrike), have very high requirements on something such as proper temperature, the amount of rainfall and enough food [5].

2.2.2 North America

As the global temperature is rising, both short-distance and long-distance migratory birds are affected, particularly on their migratory time.

The general pattern in America shows the alternations in birds' migration timing correlated with temperature changes from 2010 to 2016. In every state, over half of the species that showed alternations in their migration time were long-distance migrants. Taking the South Carolina as a typical example. 49 species analyzed in South Carolina from 2010 to 2016 show some alternations in their migration patterns due to the rising temperature. Thirty of the species that show alternation in their migratory patterns are long-distance while 19 species were short-distance migrants. This is a common tendency in other states such as Alaska and Maine as illustrated in Fig. 1. Besides, summer resident species stayed longer as temperature increased while winter resident species left earlier and stayed for less time as temperature increased. In other countries like Mexico and Canada, the alternations were similar [6].

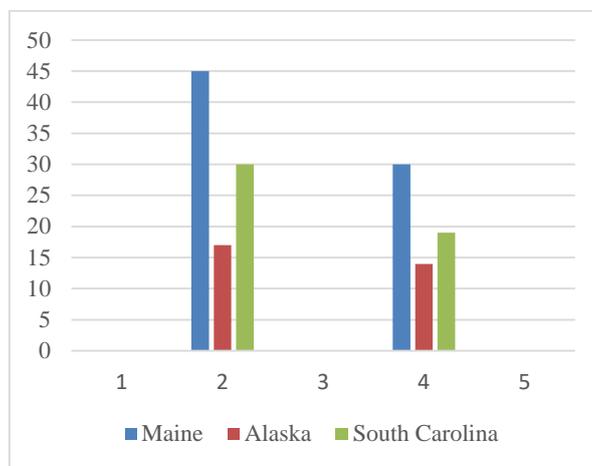


Fig. 1. Number of long-distance and short-distance migrant species showing changes in migration patterns due to changing temperatures or over time during 2010-2016 in Alaska, Maine, and South Carolina. The left side of the graph is the number of long-distance migrants in three sites while the right side of the graph is the number of short-distance migrants in three states. The vertical line represents the bird counts.[7]

2.2.3 Africa

The temperature in Africa is high, but majority of migratory birds advance their migratory time because of the global warming.

There was an estimation on 13 species of trans-Saharan migrants. Analysis are Over the 15 years from 1993 to 2007. Although the temperature is high in Africa, since the global warming, 12 species showed the advanced timing on migration gradually in each year. Only one species migrated (Hippol) later as temperature rises every year. This model can also strongly support that global warming can affect the migrants in Africa as depicted in Fig. 2

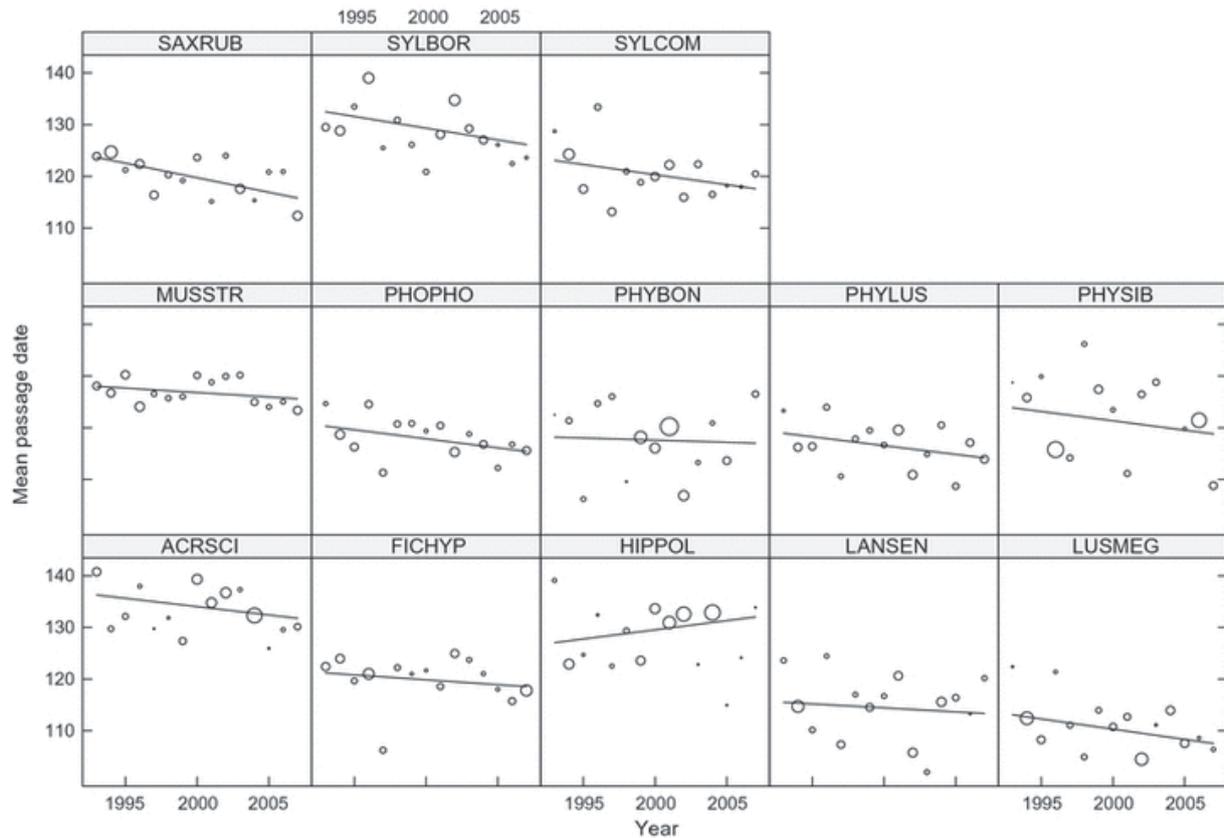


Fig. 2. Temporal trends in estimated mean passage date of 13 trans-Saharan migrants. Each point is the mean passage date pooled across the three sites. The dot size is proportional to the sample size. Lines through data represent best-fit linear regression lines weighted by sample size. Negative slopes indicate trends to earlier migration.[8]

3. The impacts on number of migratory birds

The global warming also has impacts on the number of migratory birds in some indirect way. Migrant birds are much more likely to be susceptible to the change on environment, especially the global warming than their resident species because their annual cycle is complex. Moreover, the long-distance migration routes are probable different sites during the different time.[9]

Due to the increase of energy demand and the unpredictability of food supply, the risk of death from predation and hunger will increase, i.e., the migration mortality of birds will increase. Longer journeys increase these risks and may lead to a decline in the number of migratory birds. Some migratory birds on the European continent have to fly farther because of the northward migration of bird breeding grounds caused by global warming. This is also the biggest threat these birds have faced since the ice age more than 10000 years ago. Some warblers fly 400 kilometers more from Africa to their migration destination than before, and the journey back and forth twice a year is 6000 kilometers. For some birds, flying tens of kilometers more is facing the test of life and death. As a result, the number of migration birds are decreasing. Global warming puts many birds in danger of extinction. Scientists point out that if the global temperature rises by 2 degrees Celsius compared with that before the industrialization era, 38% of birds in Europe will become extinct, while the proportion in northeast Australia will be as high as 72%.

There is a compelling evidence and example that Afro-Palaeartic (A-P) migrant bird populations have declined in Europe in the twentieth and twenty-first century as summarized in Table2. Under the commonly and global recognized classification of migratory strategy outlined by Bird Life International (2004), 126 bird species are considered as A-P migratory birds, and the estimates of the total numbers of this type of individual birds involved ranging from 2.1 billion to more than 5 billion. Analyses of long-term data sets on the international (European) and national (individual countries

within Europe) scopes have shown that the number of A-P migrants is diminishing. Examination of long-term data sets in Europe uncovers two comparably distinct periods of decline that are broadly consistent between studies and are evident on both national and European scales. At the European level, two studies using data from the Birds in Europe database (Bird Life International 2004) denote that A-P migrants declined markedly in Europe during 1970–1990, but less so between 1990 and 2000. Of the 119 species considered, 40 (33%) declined significantly and 15 increased between 1970 and 1990, whereas between 1990 and 2000, numbers of increasing and decreasing migrants were approximately the same. The greatest decreases between 1970 and 1990 were among birds that winter in open savannas and breed on agricultural land. Population trend data from the Pan-European Common Bird Monitoring Scheme (PECBMS) for widespread European birds over three decades show that A-P migrants that predominantly winter in arid northern areas show significantly different trends from those that winter in the humid southern areas in Africa. The latter group declined consistently from 1980, whereas the former showed a sharp decline from 1980 to 1994 (36%) but then an increasing trend from 1995 to 2009 (14%), suggesting a partial recovery of some species [10].

Table 2. There is a table about long-term (1980–2009) population trends of selected European Afro-Palaeartic migrants.

Species	Long-term Pan-European trend (%)	Mean annual rate of change (%)
Ortolan Bunting <i>Emberiza hortulana</i>	-84	-6.12
European Turtle Dove <i>Streptopelia turtur</i>	-69	-3.96
Northern Wheatear	-66	-3.65
Oenanthe <i>oenanthe</i>	-66	-3.65
Icterine Warbler	-50	-2.36
Hippolais <i>icterina</i>	-50	-2.36
Eurasian Wryneck	-49	-2.30
Jynx <i>torquilla</i>	-49	-2.30
Black-tailed Godwit	-45	-2.04
Limosa <i>limosa</i>	-45	-2.04
Wood Warbler	-33	-3.17
Phylloscopus <i>sibilatrix</i>	-33	-3.17
Willow Warbler	-33	-3.17
Phylloscopus <i>trochilis</i>	-33	-3.17
House Martin	-18	-6.08
Delichon <i>urbica</i>	-18	-6.08
Barn Swallow	-18	-6.08
Hirundo <i>rustica</i>	-18	-6.08
Common Sandpiper	-21	-0.81
Actitis <i>hypoleucos</i>	-21	-0.81
Common Cuckoo	-21	-0.81
Cuculus <i>canorus</i>	-21	-0.81
Pied Flycatcher	-21	-0.81
Ficedula <i>hypoleuca</i>	-21	-0.81

It was covered by the Pan-European Common Bird Monitoring Scheme (PECBMS), in order of magnitude of decline. Trends are derived from the combined breeding bird surveys of the following 25 countries all around the world.[11]

4. Conclusion

In summary, this study discusses the impacts of climate change on the timing of migrating and total number of migratory population in global scale. The rising temperature leads the bird species to

migrate earlier than before. Bird in different region response differently but they also show trends of being affected. Besides, global warming has a negative impact on the migration number as well. On the perspective of impact on migration time, most research have an agreement of the global warming have influence of early migratory behavior. In global scale, bird population in 1980s and late 1990s shows trend of early arrival on the breeding area than 1970s and 1960s. In different part of the world, different species have display different migratory behavior changes. In Europe, the impact is not only on the early migration behavior but also on the nesting time of the migratory population. In North America, the rising temperature affects the migratory timing of both long- and short- term migratory bird population. Additionally, in Africa, most of the bird population shows advance in migration timing. Furthermore, the global warming is impacting the number of migratory bird population indirectly. Because the complex migration pattern, the increase in energy needs and the unpredictability of the food supply has made the migratory bird hard to survive in the breeding area and reproduce. Therefore, the total number of migratory birds have shown a decrease overall. These results offer a guideline for the people don't know about how will the global warming has an impact on the migratory species. And hopefully, they will start do something to decrease the individual's carbon emission and make the possible bad end come after scientist have find a way to solve the problems that it might cause.

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