Introduction

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> *We behold the face of nature bright with gladness, we often see superabundance of food: we do not see, or we forget, that the birds which are idly singing round us mostly live on insects or seeds, and are thus constantly destroying life; or we forget how largely these songsters, or their eggs, or their nestlings, are destroyed by birds and beasts of prey; we do not always bear in mind, that food may be now superabundant, is not so at all seasons of each recurring year. I should premise that I use the term Struggle for Existence in a large and metaphorical sense, including dependence of one being on another.*
>
> Charles Darwin (1859, p. 116)[1]

Perhaps the seasonal migrations of birds across the highest mountains on Earth, the Himalayas, represent the ultimate 'struggle for existence' that Charles Darwin referred to in 1859 when *The Origin of Species* saw the light. Imagine yourself being born somewhere in the northern Siberian taiga. Autumn approaches and soon the area freezes to a mind-numbing −50°C. Gales howl from the Arctic at wind speeds of more than 100 km.h^{-1}. The ground freezes and food is difficult to find, but somewhere in the Deep South along the coasts from Myanmar (Burma) to Iran, or even across the Indian Ocean along the East African coasts, there is much better weather and much more food. Would you not rather migrate too if you had wings to take you there? However, between the Deep South and the Frozen North lies Central Asia, a region replete with high mountains and deserts. Central Asia is also bordered to the south by the Himalayas, with the Hindu Kush to the west and the Hengduan Shan to the east. The highest peaks in this mountain range frequently reach 8000 m and above (more than 100 peaks are higher than 7300 m); more important, though, the few lowest valleys that present a path through this barrier are still higher than 5000 m, with more in the east than in the west. (Figure 0.1). In the field of ornithology, this connection between North Asia and South Asia and beyond is named the 'Central Asian Flyway' (Figure 0.2).

The Central Asian Flyway covers a vast area, encompassing about 15 countries between the Arctic Ocean and the Indian Ocean. After leaving Siberia, the migratory birds in this flyway first cross the Altai Mountains, then the Gobi and Taklamakan Deserts and then the Tian Shan (Mountains). If migrating birds were to decide to circumvent these mountains that rise up to 6000 m, then they could not benefit from the lush meadows and deciduous forests before they have to cross the Taklamakan Desert. After flying over this desert, they have to cross the Tibetan Plateau, after which loom the high Himalayas, straddling almost

[1] Darwin, C. (1859). *The Origin of Species by Means of Natural Selection or the Preservation of Favoured Races in the Struggle for Life*. Reprinted by Penguin Books Ltd, London (1968).

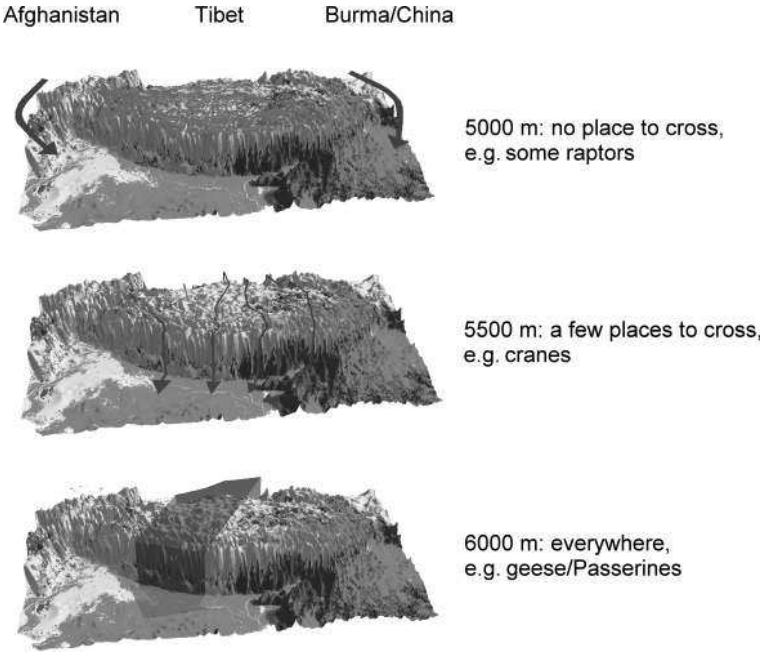

Figure 0.1. A digital elevation model of the area between the Pamirs in the west and the Hengduan Shan mountains of Sichuan in the east (vertical scale exaggerated 1000x) shows that there are no routes through this vast barrier of the Himalayas and the Tibetan Plateau for birds that cannot fly higher than 5000 m above sea level (or about 540 millibar). If the maximum ceiling is 5500 m (500 mb), then there are only a few routes open for passage, with more in the east than in the west, but if their ceiling is 6000 m (475 mb), nearly the whole area can be crossed even though peaks have to be circumvented. (A black-and-white version of this figure will appear in some formats. For the colour version, please refer to the plate section.)

across the breadth of the flyway. The Himalayas stretch more than 2400 km between Namche Barwa in the east and Nanga Parbat in the west. The width of the Himalayas ranges from about 400 km in the west to about 150 km in the east. This young mountain range is bounded to the north by the vast Tibetan Plateau and to the south by the plains of the rivers Indus, Ganges, Brahmaputra and Irrawaddy, but between these southern plains and the Greater Himalaya and the Lesser Himalaya there is still another mountain range to be passed by birds migrating south, namely the Siwalik Range, which runs for the entire length of the western and central Himalayas. Further to the west, the Himalayas merge into the Zanskar Range, the Ladakh Range, the Pir Panjal, the Karakoram, the Hindu Kush and the Pamirs. These far western mountain ranges include many peaks that are higher than 7000 m and even 8000 m.

Birds go to incredible altitudes: we have seen Horned Larks foraging in snow-clad scree in mid-summer at 6200 m above sea level (a.s.l.); we found nests of Black Redstarts at 5200 m a.s.l. and of Common Redshanks at 4800 m a.s.l. We have seen Golden Eagles being attacked by Bar-headed Geese, and vice versa, hundreds of metres above our heads while we ourselves were at some 4800 m. Resting at a pass (5670 m a.s.l.), we have

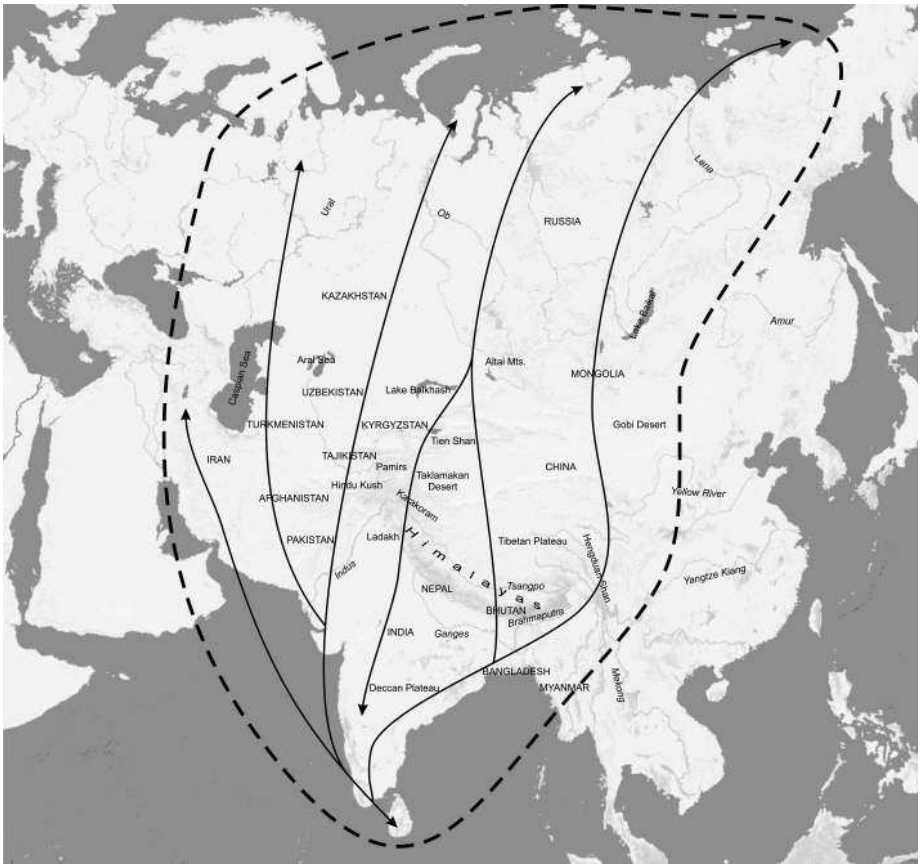

Figure 0.2. The Central Asian Flyway covers a vast area, encompassing about 15 countries between the Arctic Ocean and the Indian Ocean. Birds migrating in this flyway have to cross many obstacles (from north to south): the Altai Mountains, the Gobi and Taklamakan Deserts, the Tian Shan Mountains, the Tibetan Plateau, the Karakoram, the Pamirs, the Zanskar Range, the Ladakh Range, the Great Himalaya, the Lesser Himalaya, the Pir Panjal Range and finally the Siwalik Range. Many of the mountain peaks are higher than 7000 m and even 8000 m, and mountain passes are typically between 4000 m and 6000 m.

witnessed flocks of Ruddy Shelducks flying across to the myriad wetlands of eastern Ladakh. We have seen Tibetan Snowfinches feeding at 6000 m. Telemetry studies have also shown that Bar-headed Geese and Steppe Eagles fly higher than 7000 m in the Himalayas. Yes, indeed, birds can go to incredible altitudes – so high that earlier observers put forward the notion that they went so high that they could not fly any more: when in 1827 the American Quaker Joziah Harlan led an Afghan army across the Hindu Kush into what is now Turkmenistan, he observed 'storks walking over the passes' because putatively these passes were too high for the storks to cross on the wing, and he derived the ancient Greek name *petiamplus* for what we now call the Hindu Kush ('slayer of Indians') from the Persian *petipluampus*, meaning (according to Harlan) 'peaks over which eagles cannot soar'. Even though we are not aware of any recent observation of pedestrian bird crossings

of these highest mountain passes on Earth, the point is that people have been standing in awe of these mountains and have queried the possibility that birds could fly over them.

How high is 'high' actually? This question is not easy to answer, but to give the reader a feeling for these incredible altitudes: one of the highest permanently occupied villages is Kibber, in the district of Lahul-Spiti, at 4200 m a.s.l. Possibly the highest permanent camp by pastoralists is close to Kibber at 5200 m (the head of the family had eight living children – of these one was living in Germany, one in Japan and one in New Delhi when we interviewed him). At this altitude, the partial oxygen pressure is only about 55 per cent of that at sea level. More telling, perhaps, is the fact that even though arterial human blood still contains oxygen, at this altitude the oxygen saturation of the venal blood is reaching only 30 per cent. In the perpetual state of semi-war between Pakistan and India, troops on both sides of the frontier try to occupy ever-higher permanent posts to give their howitzers the advantage, but soldiers have discovered at a high cost that neither Indian nor Pakistani can live longer than about six weeks in camps higher than about 5200 m a.s.l. But the barrier to bird migration is higher and goes up into the eternal ice, which starts here at about 6000 m. The higher one gets into these mountains, the shorter the window of opportunity to find food; at the lowest places the growing season for plants is still some five months at 3000 m a.s.l., but at 5500 m this is reduced to just a month (Figure 0.3). This book focuses

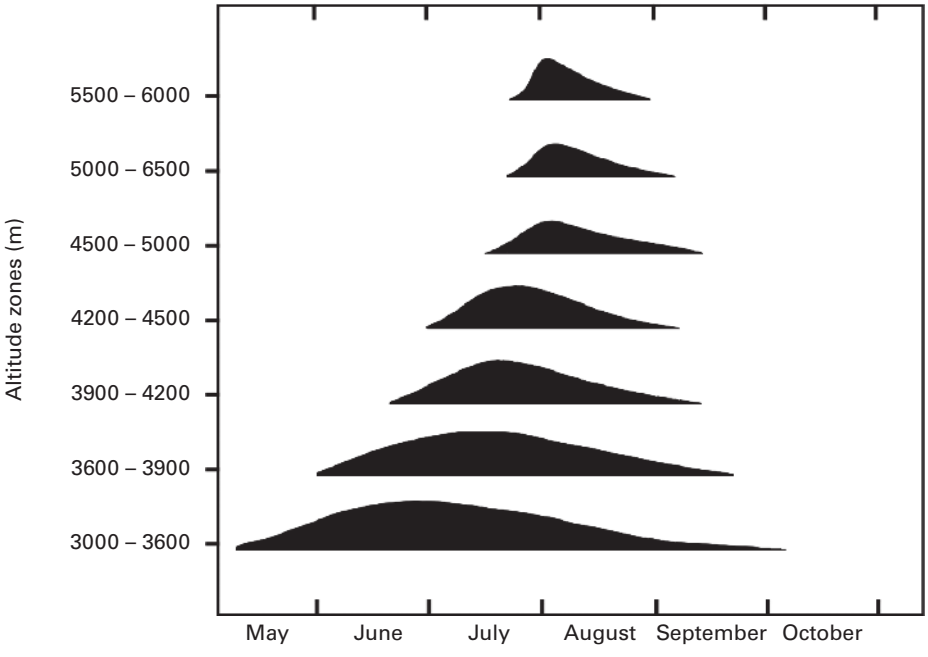

Figure 0.3. The growing season decreases with altitude in the Himalayas, and the onset of spring advances, but the end of the growing season does not get much delayed. This could imply that there is much less suitable habitat available in spring for birds migrating north, then in autumn for birds migrating south (after Figure 12 in M.S. Mani, 1978. *Ecology and Phytogeography of High Altitude Plants of the Northwest Himalaya*. London: Chapman & Hall).

on how birds are able to pass this nearly unsurmountable barrier in the Central Asian Flyway.

We, the editors, have been struck with awe every time we were observing these birds doing the nearly impossible, and out of that awe arose our wish to better describe what is perhaps much more of an accomplishment than the well-featured annual migration of the zebra and wildebeest over the Serengeti or the sardine run along the Wild Coast of South Africa. The annual struggle of the ducks, geese, cranes, raptors, waders and passerines over the Himalayas is a triumph of evolution. We thus invited many specialists to write chapters for this book, because without their deep knowledge of the Himalayas in the wider sense of the word, we could not construct the portrayal of this triumph. Together as a team of authors, we represent approximately 2000 man-years of observation and thought, give or take 500 years. That is minute as compared to the accumulated knowledge with regard to the European or American Flyways, but is not minute in comparison to the study of the Serengeti migrations referred to earlier. To the best of our knowledge, we are the first to bring together this information concerning the bird migration across the Himalayas, not under the assumption that this will be the ultimate volume describing this seasonal trek, but in the hope that it will focus and stimulate research and the description of the natural history of one of the most challenging places for natural selection to act.

In this book, we brought on board not only ornithologists and ecologists, but also geologists, climatologists, glaciologists, sociologists, archaeologists and aviators. Before the Himalayas came into existence, the ancestors of the present-day birds may have flown across the Tethys Sea to reach wintering areas on the Indian Island, which was then drifting northward. The migration must have become easier as the island came closer to the Eurasian land mass. Once the Indian Plate collided with the Eurasian Plate some 45 million years ago, the Tibetan Plateau and the Himalayas rose up, creating the most massive physical barrier in the world for present-day migratory birds. To come to grips with this, we included chapters on understanding the historical processes that created this joint barrier of the Tibetan Plateau and Himalayas. Birds have been carrying out this epic journey probably for tens of millions of years, as alluded to earlier, and apparently adapted as the mountains grew. When the barrier arose, the climate changed. In this day and age of climate change, of course we must pay attention to the changes that took place in the Himalayas. The formation of the Himalayas, and especially the rise of the Tibetan Plateau in the recent 20 million years, altered the monsoon regimes that dominate the current climates of Asia. The rise of the Himalayas and the associated mountain formation made the climate of the land beyond progressively drier, forming desert habitats in Central Asia. But the Himalayas also protected the Indian subcontinent from subarctic winds. Despite the differences in opinion over the exact pattern, consensus exists that the uplift of Central Asia influenced the current monsoon regimes in Asia during the Miocene. The rise of the Tibetan Plateau may even have been one of the causes of the ice ages. To grasp what drives the weather patterns (needed to appreciate air movements that birds use to help them across these mountains) we included chapters that help the reader to understand weather and climate. We even included work by glider pilots to help explain how air movements may help (or indeed, hinder) birds in their efforts to cross the massive mountains.

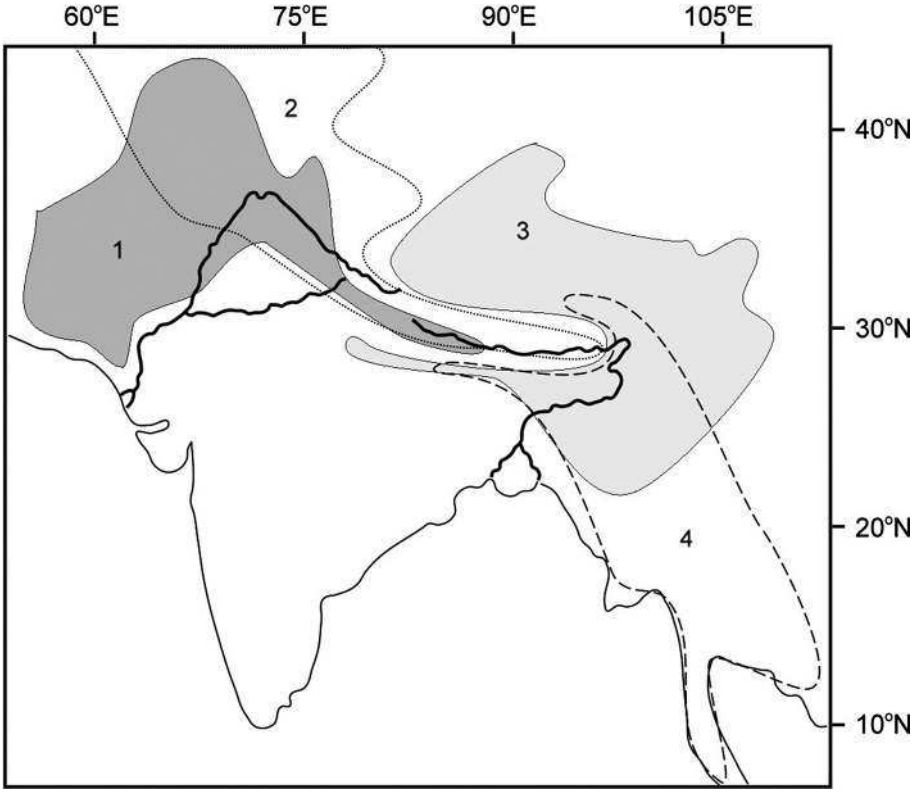

Figure 0.4. The major phytogeographical areas for the high-altitude flora of the 'Roof of the World': 1 – Mediterranean affinity, 2 – Central Asian affinity, 3 – Indo-Chinese affinity and 4 – Malayan affinity (after Figure 47 in M.S. Mani, 1978. *Ecology and Phytogeography of High Altitude Plants of the Northwest Himalaya*. London: Chapman & Hall). The high mountains truly represent a crossroads between East and West.

Since the end of the Pleistocene, these climate changes are quite well known, although there is still controversy over the extent of ice cover on the Tibetan Plateau and the Himalayas. Some contend that the Tibetan Plateau was covered with an ice sheet, while others argue that ice sheets were restricted only to the mountain ranges. In any case, it is thought that the extent of ice in the Himalayan region was relatively restricted, generally extending less than 10 km from contemporary ice margins. It is apparent that glaciers in the Himalayan region reached their maximum extent early in the last glacial maximum (about 20,000 years ago). These glacial advances significantly influenced the hydrology and the wetlands of the Himalayas. The Himalayas hold about 15,000 glaciers, which store about 12,000 km^3 of fresh water. They cover an area of about 1.1 million km^2, and include the territory of eight countries. They are the source of 10 major rivers that together provide irrigation and drinking water to one-third of the world's population. The vast icecaps of the Himalayas are perhaps the world's largest freshwater reserve after the polar icecaps.

Before the advent of humans in the Himalayas, the availability of wetlands for migratory birds must have been much higher than today. Much of the water melted

from the glaciers then fed the wetlands in the Himalayan valleys. The rapidly growing human populations and their ceaseless activity claimed innumerable wetlands and converted them for human use. All the valley bottom wetlands at altitudes lower than ~3500 m a.s.l. have been converted to agricultural land. But the region still has a myriad of wetlands, including glacial lakes, marshes, wet grasslands, rivers, streams, ponds and artificial water reservoirs, some of which are relatively undisturbed, at higher altitudes. And still the high lands of the Himalayas, Pamirs and other mountain ranges and the Tibetan Plateau (Figure 0.2) form a botanical Valhalla, because here four major phytogeographical regions intermingle (Figure 0.4), providing a high diversity of seed sources for migratory birds. Lakes in the Himalayas play a crucial role in driving the hydrological regime of mighty rivers such as the Ganges, Brahmaputra and Indus, and act as buffers between glacial meltwaters and outflows to smaller rivers and streams. Apart from supporting countless migratory birds, these wetlands also support unique ecosystems and services that sustain the livelihoods of almost a quarter of the world's human population. They are thus crucial in sustaining biological and cultural diversity. Many of these wetlands also play important roles in the religious and social fabric of life in the Himalayan region.

The geographical features and climatic vagaries have limited the production systems to agriculture and livestock rearing in the Himalayan-Tibetan region. Agriculture in the region is believed to have started in the second millennium BCE. Retrieval of carbonized seeds from Neolithic sites, and the seeds of wild wheat and barley from the aceramic and ceramic levels, provides evidence that the Neolithic settlers in the Himalayas cultivated both wild and domestic plants. Recent excavations of the remains of a horse from a megalithic site in the Garhwal Himalayas indicate that pastoral communities had arrived at the beginning of the second millennium BCE. The transhumant livestock grazing in the Himalayas was, however started by the Aryans in 1500 BCE. Much knowledge concerning the advent of man in these mountains can also be learned from petroglyphs that can be found at many places in these mountain ranges.

This was only the beginning of land use changes driven by man. Wetlands continue to disappear as the needs of humans increase and their aspirations change. The most prominent factors that are threatening the wetlands are land reclamation for agriculture, and extraction of fuel wood, fodder and timber resources from the wetlands. Since the disappearance of wetlands is threatening to disrupt bird migration systems in the Himalayan region, it is crucial to understand the dynamics of the extent of wetlands in relation to other land use in the region. The focus of agriculture in the Himalayan region is slowly shifting from traditional cereal crops to more lucrative cash crops such as fruits and vegetables. This transformation from subsistence to commercial agriculture poses new threats to migratory birds. Since the demand for cash crops is increasing, to cater to the needs of a burgeoning human population, wetlands are being drained and reclaimed for agriculture, which reduces the extent of foraging areas available for migratory birds. Modern agriculture also makes indiscriminate use of government-sponsored, subsidized, artificial fertilizers, insecticides and herbicides, which pollutes the wetlands and reduces the abundance of insects and aquatic invertebrates that the migratory birds rely on. Likewise, governments build roads in the Himalayan-Tibetan region, also for

geopolitical reasons, thus making agriculture economically viable at the household level. Therefore, modern agriculture, characterized by monoculture and extensive use of chemicals and pesticides, threatens the bird migration system in the Himalayan-Tibetan region. However, it is not only arable agriculture that is changing in these vast lands straddling the Central Asian Flyway of migratory birds.

Modern livestock production systems are also threatening migratory birds and their wetland habitats. The wetlands on the Tibetan Plateau and surrounding regions are scattered among the grazing lands of pastoral nomads. Government agencies provide subsidized hay in winter, thus boosting domestic livestock numbers at ever higher altitudes. The livestock then encroach on the grasslands and wetlands in summer. The meadows around lakes, rivers and streams are therefore intensively grazed by domestic livestock. Since the needs of the pastoral communities on these rangelands are increasing and their aspirations are changing, the livestock population is increasing steadily, which is putting immense pressure on the wetland resources. For example, the population of Pashmina goats is increasing rapidly. Within India, there is high pressure from the Kashmiri government to increase Pashmina production to absorb about 50,000 families, who lost their livelihoods due to the ban on *Shahtoosh* ('king of wool' in Persian – made from the now Globally Threatened Tibetan antelopes). In addition, with globalization, some nomads look down on their pastoral lifestyle as primitive. Thus, they tend to settle down, especially near water bodies such as lakes and streams, thereby increasing the pressure on the wetland resources.

The Himalayas form a unique and popular tourist destination. Tens of thousands of people from all over the world visit the natural and cultural sites in the Himalayan region. An increasing number of tourists also visit various lakes for observing migratory birds, and insensitive tourists often disturb and scare these birds away. Furthermore, indiscriminate camping at the edge of high-altitude lakes pollutes the wetlands, thereby affecting the abundance of aquatic insects. Military activities close to the wetlands also cause damage and disturb the birds. Since the Himalayan range straddles the boundaries of many countries with strained relationships, these issues are becoming more serious. The military also feeds dogs around the military camps. Some of these feral dogs wander off into the mountains, and predate the eggs and chicks of migratory birds. As if these issues are not problematic enough for bird migration, global climate change is increasingly seen as a major threat to migratory birds in their breeding and/or wintering areas. Increased glacial melting is resulting in the retreat of nearly two-thirds of the 15,000 glaciers in the Himalayas. With more than 2 billion people dependent on this glacial melt, the wise use of wetlands is critical for maintaining steady water flows and reducing the risks of floods. Apart from being water banks, the wetlands in the Himalayan region play a crucial role in supporting millions of migratory and resident birds that forage and nest around these lakes and in these high-altitude wetlands.

So, there may be problems enough to threaten the long-term viability of the Central Asian Flyway. Are there solutions to protect this migratory thoroughfare? There is a glimmer of hope due to the socio-religious protection of birds by some communities in the Himalayas. Bottom-up bird conservation is not uncommon in the Himalayan

region. For example, the Chinese government has initiated a major bottom-up community-based conservation programme to train local people to monitor the health of the wildlife habitat. In India, people have managed wetlands in the Himalayan mountains for centuries, for subsistence and livelihood. Several communities across the Indian Himalayas are actively engaged in managing lakes and rivers. For instance, local people in the Ladakh Trans-Himalaya discourage tourists from camping along the shores of lakes and encourage them to camp only at the designated sites. Communities have also freed areas from grazing so that wild animals can thrive. But is there a role for the state governments too? States, not local communities, are signatories to the Ramsar Convention. We hope this book will serve as a clarion call for the governments of Afghanistan, Bangladesh, Bhutan, Burma (Myanmar), China, India, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, the Russian Federation, Tajikistan and Uzbekistan to take a hard look at the effectiveness of their conservation efforts.

Aldo Leopold already taught us that conservation is tightly linked to ethics. Although, perhaps too often, we may think that conservation boils down to 'it is the economy, stupid', there is still the lingering thought that ethics may supplant – at least partially – money when it comes to sustaining conservation. It is in the Himalayas that Buddhism took strong roots. Compassion towards sentient beings is at the heart of Buddhism. Furthermore, birds have a special place in Buddhism. Garuda is a mythological bird of Buddhists and Hindus, the main inhabitants of the Himalayas. Hindus even worship this mythical bird. The Black-necked Crane is another bird that features in folklore, as well as myths, legends and songs in the Himalayan region. Furthermore, people regard most of the lakes in the Himalayas as sacred. The most sacred of all is Mansarovar Lake in Tibet, revered by both Buddhists and Hindus. Of course, we do not claim that Buddhism and Hinduism are the only ethical systems that could uphold conservation in this part of the world: we are only too aware that in this part of the world ethical systems such as atheism, Christianity, Islam, Marxism and Sikhism all compete to offer guidance to people living with the great migration across the Himalayas in stepping up their conservation efforts. Indeed, time is running out.

Wetlands form the backbone for this great migration in the dry grasslands and scree plains that cover vast tracts of the high-altitude lands, but high-altitude wetlands are increasingly being degraded due to intense grazing by livestock and resource extraction by farmers, whose needs are increasing apace. In other words, the 'fuelling stations' for the migratory birds are disappearing, making migration to and from the south increasingly difficult, which may ultimately lead to the extinction of these migratory birds. Increasing human populations and associated developmental initiatives are diverting water away from these wetlands. Furthermore, many of the wetlands associated with the Himalayan river systems are small and widely scattered, but they offer suitable habitat for the migratory birds. These small wetlands are fed by glaciers, but because of their small size and dispersed nature, they are generally ignored by conservation planners. These wetlands do come under the purview of the Ramsar Convention, but are insufficiently distinct and individually important for bureaucrats to act on; however, these ephemeral or dispersed wetlands are crucial for the success of avian migration across the Himalayas and need to be delineated and conserved.

Isolated studies have been carried out on different aspects of the ecology of migratory birds and wetlands in the Himalayan region, but there has not yet been an apparent effort to synthesize the existing knowledge. This book is an attempt to extract relevant information from the existing literature, invite current researchers to share their new findings and generate new knowledge that is relevant to the conservation of migratory birds and wetlands in the Himalayan region.

Many chapters in this book focus on Ladakh in the western part of the Himalayas and in the Trans-Himalaya of India. Anyone knowledgeable about the vast Himalayan range from the West to the East knows that Ladakh does not represent that whole range at all. However, in the past 20 to 40 years, access to most of this vast barrier to study avian migration was difficult: in the West, the wars in Afghanistan and Tajikistan prevented most if not all ornithologists from going to the mountains, and civil unrest in northern Pakistan led to low numbers of birders in the region. Similarly, in the Central Himalayas, in Nepal and in the Far East, the lack of permits given by the Indian authorities and the then pariah state of Myanmar also led to a dearth of observation opportunities for serious birdwatchers. Only in Ladakh was there a free window for study and research. Hence the predominance of studies on Ladakh in the current book. We do not apologize for that: on the contrary, we thank the Ladakhi people and authorities for being so open-minded in facilitating overseas scientists but also local ones to study their mountainous paradise.

A Note on the Names of Places and Geographical Features in this Book

Many geographical features have been mentioned in this book. That is, of course, a consequence of the subject of migration ('The periodic passage of groups of animals from one region to another for feeding or breeding' as defined by www.biology-online .org/dictionary/ accessed 31 May 2016). The editorial team has taken great pains to find and verify the names and coordinates of these locations. All these names and coordinates can be found in the gazetteer at the end of this book. We had some difficulty in finding standardized names, but took as a starting point *The Times Comprehensive Atlas of the World*, eleventh edition. If we could not find a name there, we chose to follow Wikipedia. If we could not find it there, we chose to follow names as found on the Internet through the Google search engine (last accessed 1 June 2016). The Appendix includes more than 400 locations within the Central Asian Flyway, and gives names in Tibetan too.

Acknowledgements

A book such as this could not of course have been made by us alone. First we want to acknowledge our indebtedness to Dominic Lewis who, as Editor Life Sciences of the Press was willing to propose our book outline to the Syndicate. Equally important was Patricia Meijer of Wageningen University, who assisted us with all administrative details, but who also vigorously kept track of the progress of all authors, checked