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**Dispersion patterns of Holarctic-breeding,
migrant landbirds:
global paradigms or regional patterns?**

By

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Thesis submitted for the degree of
Master of Science

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April 2003

To my late father

Who would be so proud

University of Cape Town

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ABSTRACT

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The most extensive avian migrations involve species that breed at temperate latitudes (Holarctic) and move south for the winter. These long distance migrations are divided into three major flyways, the Nearctic-Neotropical, Western Palearctic-Afrotropical and Eastern Palearctic-Oriental flyways. The very marked global variation in land area availability, existence and nature of potential barriers to migration and relative availability of different habitat types is predicted to have some influence on migrant distributions. This study quantifies the breeding and wintering ranges, habitat occupancy, diet and foraging mode of each migrant taxon on each of the three flyways. It aims to compare how patterns of migration between the temperate and tropical latitudes vary spatially in response to a) the geography of the land masses, b) relative availability of different habitat types, c) dietary preferences and d) foraging mode.

The very different physical conditions encountered by Holarctic-breeding birds on each of the three flyways are hypothesised to influence strongly the non-breeding distributions of these taxa. Taxon attenuation was more rapid in the Neotropics and the Orient than in the Afrotropics. On all three flyways, taxon richness decreased with increasing distance from the breeding grounds. There was a positive relationship between land area and taxon richness on the Western Palearctic-Afrotropical flyway, but no such relationship was evident on the Nearctic-Neotropical or Eastern Palearctic-Oriental flyways. The land area constrictions and ocean barriers of the Neotropics and the Orient limit southward penetration of migrant taxa. Some taxa are capable of making large ocean crossings, but others avoid them completely. Widespread interspecific leapfrog migration exists on the Nearctic-Neotropical and Western Palearctic-Afrotropical flyways but not on the Eastern Palearctic-Oriental flyway. These findings support the idea that land area bottlenecks and the existence of ocean crossings prevent some taxa from optimising their migratory end-points. Body weight had some effect on migration patterns. Taxa whose non-breeding ranges were centred around the tropics tended to be smaller than those at temperate latitudes, but many birds of all body weights were present at all latitudes.

The relative availability of different habitat types to potential migrants during both the breeding and non-breeding season differs across flyways: this is predicted to have some influence on habitat occupancy. In most cases, migrant habitat was strongly non-random. There was considerable variation in the habitat types selected and avoided on both the breeding and non-breeding grounds of all three flyways. Globally therefore, habitat availability alone is not a good predictor of habitat occupancy. Similarities in habitat occupancy between the breeding and non-breeding grounds on the Nearctic-Neotropical and Eastern Palearctic-Oriental flyways, despite differences in habitat availability, strongly suggests that wintering habitat occupancy has some impact on breeding habitat occupancy.

Seasonal fluctuations in food availability are likely to be the primary force driving migration. Different food sources fluctuate differently, and the tendency to migrate is likely to be associated with those foods that are seasonally most variable and ephemeral. The majority of migrant taxa were at least partially insectivorous on all three flyways, but the prevalence of different diets varied across all three flyways. Migrants on the Old World flyways had a similar diet spectrum, but the Nearctic-Neotropical flyway differed, with a greater proportion of taxa including fruit, nectar or seeds in their diet. Overall, dietary diversity was greater on the wintering grounds than on the breeding grounds, with some insectivorous birds supplementing their diet on the non-breeding grounds with fruit, nectar and seeds. Although the proportional representation of different food types in the diet of migrants varies between seasonal ranges and flyways, some trends linking diet with habitat occupancy and migration distance were repeated across flyways. Patterns of bird migration are linked not only to food, but have also been linked to foraging mode. The prevalence of different foraging modes varied across flyways but some trends were repeated within habitats across each of the three flyways. Thus, information about site (distance from the breeding grounds) and habitat buffering allow predictions to be made about diet and foraging modes of migrants on any flyway.

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DECLARATION

This thesis reports the results of original research which I carried out under the auspices of the Percy FitzPatrick Institute of African Ornithology, University of Cape Town. All assistance I received has been fully acknowledged. This work has not been submitted for a degree at any other university.

Signed by candidate

Jane Hamblin

30/04/2003

Date

Introduction

University of Capetown

INTRODUCTION

Migration is an adaptation evolved to cope with changes in space and time in the physical and biotic characteristics of the environment (Gauthreaux 1982): numerous types of migration take place on all spatial and temporal scales (Lack 1944, Dorst 1962, Moreau 1972, Karr 1980, Ketterson & Nolan 1983). The most extensive avian migrations involve species that breed at temperate latitudes (Holarctic) and move south for the winter (Chesser 1994). These Holarctic-breeding birds undertaking long distance migrations to the tropics follow three major routes, the Nearctic-Neotropical, Western Palearctic-Afrotropical and the Eastern Palearctic-Oriental flyways.

Seasonal changes in resource abundance drive these movements across all geographical scales (Levey & Stiles 1992). The very marked seasons of the Northern Hemisphere provide rich resources for a huge temporary breeding population in summer, but during winter many birds must migrate south towards more mesic areas. Southward movements of migrants from the Holarctic occur at the end of the boreal summer (August to October) with birds returning north at the end of the boreal winter (March to May).

Attempts to explain present day migratory patterns date back more than 100 years (e.g. Gätke 1895), and movements between the Palearctic and the Afrotropics are the most studied of the world's migration systems (Rappole 1995). Studies of geographical trends in migration have been concentrated historically in the areas of the North American and European breeding grounds because accurate distributional data are most readily available for these areas (Chesser 1998). Apart from the Australian endpoint, the Asian migration system, especially of land birds, has been much less studied than its Afrotropical and Neotropical counterparts.

The Eastern Palearctic-Oriental and the Nearctic-Neotropical systems are very similar to each other in terms of number of migratory species, while the Western Palearctic-Afrotropical flyway has far fewer species (Rappole 1995). According to Rappole (1995), 338 Eastern Palearctic species are known to migrate from the Palearctic to the tropics of southern India, South East Asia and Indonesia, and 318 species migrate between the Nearctic and the Neotropics. Only 185 western Palearctic species are known to migrate to the Afrotropics.

Many families of birds in geographically disparate areas include long-distance migrants (Mönkkönen *et al.* 1992), but there are minimal taxonomic affinities between Palearctic-breeding migrants and Nearctic-breeding migrants. This is because the Old World and New World have not had contact for around 100 m.y. (Axelrod & Raven 1972). On the African and Asian migratory routes there is strong congruence between families involved, and several species migrate along both flyways.

Successful migration is likely to depend on numerous factors. These include availability of land (receiving) area (Leister 1990), availability and suitability of habitat and food (Levey & Stiles 1992, Rappole 1995), presence of potential competitors (Leister 1990), and the existence of dispersal barriers. Several authors have demonstrated that climate and latitude are primary correlates of migratory patterns (e.g. Herrera 1978, Newton & Dale 1996 a,b, & Chesser 1998). Close correlations have also been proposed between migration patterns and habitat (MacArthur 1959, Chesser & Levey 1998), diet (Levey & Styles 1992, Newton 1995, Hockey 2000, Mills 2000) and foraging mode (Hockey 2000). However, these correlates of migration have all been identified at regional, rather than global scales.

Across the world, there are few places where birds do not encounter obstacles along their migratory routes. Potential geographical barriers vary greatly in their distribution and abundance and affect species in different ways. On the Western Palearctic-Afrotropical flyway, for example, the barriers of the Alps, Mediterranean Sea and Sahara Desert all lie on a west-east axis. As a result, many Eurasian migrants have evolved migratory divides, avoiding these barriers by either flying west across the Straits of Gibraltar or east around the eastern edge of the Mediterranean (Dorst 1962, Berthold 1993). Numerous studies (e.g. Stevenson 1957, Dorst 1962, Berthold 1993, Rappole 1995) have discussed the diversity of migratory pathways utilised by Nearctic-Neotropical and Western Palearctic-Afrotropical migrants in order to overcome or avoid potential barriers. Migration routes of Eastern Palearctic-Oriental migrants are not as well known, but they too are likely to be influenced by geographical factors (Dorst 1962). On the Nearctic-Neotropical flyway, migrants can avoid or minimise the length of ocean crossings through the Caribbean either by flying west, following the Mexican coastline, or by travelling southeast along the West Indies Island chain (Dorst 1962). However, Eastern Palearctic-Oriental migrants cannot avoid the ocean crossings of Indonesia and must thus fly over the South China Sea or avoid water crossings completely. Little is known about the effects of variation in physical geography on the wintering distributions and southward penetration

of Holarctic-breeding migrants. The very different physical conditions encountered by birds on each of the three flyways are predicted to have a strong influence on the non-breeding dispersion of these species.

Numerous studies have shown that a) the proportion of migrant species increases along a gradient of decreasing habitat complexity from forest and woodland to scrub and open country (Herrera 1978, Bilcke 1984, Beehler *et al.* 1986, Chesser 1994, Hockey 2000, Mills 2000), b) most migrants occupy the commonest habitats available (Karr 1976a, Mönkkönen *et al.* 1992, Chesser 1994, Hockey 2000) and c) many migrants occupy wintering habitats that resemble their breeding habitats (Hutto 1985, Pearson 1978, Fitzpatrick 1980, Curry-Lindahl 1981, Brosset 1984, Greenberg 1984, Chesser 1994). However, no study has quantified habitat occupancy by migrants as a function of the proportional availability of different habitats. It is likely that the considerable global variation in relative availability of different habitat types will have some influence on habitat occupancy.

Based on analyses of Kenyan land birds (Lack 1986a), southern Afrotropical bird families (Hockey 2000), and southern Afrotropical bird species (Mills 2000), it is evident that migration in the Afrotropics is strongly associated with insectivory, nomadism with granivory and residency with frugivory. The lack of migrant frugivores in southern Africa contrasts with both the Neotropics and Australia (Fullagar *et al.* 1988, Levey & Stiles 1992, Chesser & Levey 1998). It has been hypothesised that in the Neotropics, migration and frugivory are intricately linked (Levey & Stiles 1992, Rappole 1995). Very few studies have targeted the Eastern Palearctic-Oriental migratory bird community and no dietary analysis is yet available. However, the proportion of forest habitat available in the Orient is similar to that in the Neotropics, and is far greater than that in the Afrotropics. It is possible; therefore, that Eastern Palearctic-Oriental birds may show a similar pattern to that observed in the Neotropics, with many migrants being frugivorous. A few studies have considered the effects that food choice and foraging mode have on migratory behaviour at a regional level, but little is known at the global scale (Hockey 2000, Mills 2000, Balme 2001).

There is a tendency for scientists to use the interpretations developed for one region to explain the migratory system of others (Rappole 1995). However, each regional pattern of bird migration is unique, reflecting its own particular geographical, biogeographical and historical peculiarities (Rappole 1995). In this study, the three migratory flyways are analysed individually in an attempt to determine what ecological

factors influence the migratory patterns of birds using these flyways. The overall aim of the study is to develop a better understanding of what regional migratory patterns exist and to what extent these patterns are replicated across the three flyways.

This study has the following objectives:

- To quantify the latitudinal limits to the breeding and wintering ranges of Nearctic-Neotropical, Western Palearctic-Afrotropical and Eastern Palearctic-Oriental migrants – **Chapter 1**.
- To compare how patterns of migration between temperate and tropical latitudes vary in response to the geography of the landmasses – **Chapter 1**.
- To quantify and compare habitat occupancy in the breeding and non-breeding ranges on the three flyways – **Chapter 2**.
- To compare how patterns of migration (between temperate and tropical latitudes) vary in response to relative abundance of different habitat types – **Chapter 2**.
- To quantify diets (on the breeding and non-breeding grounds) and foraging modes of migrants on the three flyways – **Chapter 3**.
- To determine how dietary preference and foraging mode influence migratory behaviour and to compare patterns across the three flyways – **Chapter 3**.
- To provide a broad overview of global migratory patterns through comparisons across the three flyways – **Synthesis**.

Chapter 1

University of Cape Town

CHAPTER 1

Migration patterns and physical geography

INTRODUCTION

Potential geographical barriers to bird migration include oceans, mountain ranges and deserts. Although in some cases these barriers can be bypassed (e.g. by flying around, rather than over, the Tibetan Massif), they have nonetheless shaped bird migration patterns (Berthold 1996).

Many species do cross large water bodies on migration. Common Wheatears *Oenanthe oenanthe*, for example, fly from Greenland to the north coast of Spain, an over-water flight of nearly 5200 kilometres (Mead 1983). Some Bar-tailed Godwits *Limosa lapponica* make a non-stop, 11 600 km sea crossing from south west Alaska to New Zealand (Piersma and Gill 1998). However, for some land birds, water crossings as short as 15 km represent a barrier (Williams 1981). Birds that cannot land on water must either cross large water bodies without stopping or must fly around them (Kerlinger 1995). Soaring birds, such as broad-winged raptors and storks, avoid long ocean crossings because the thermal updrafts, on which they depend for energy-efficient travel, are weak and widely dispersed over water (Kerlinger 1995). Other raptors, such as falcons or harriers are capable of making longer ocean crossings (Kerlinger 1989). However, most migration routes avoid long ocean crossings, passing close to coasts or through island chains (Jeyarajasingam & Pearson 1999). If crossings are made, they are usually at the narrowest stretch of water separating landmasses (Jeyarajasingam & Pearson 1999).

Mountain barriers influence migratory patterns of lowland species. A considerable number of European species, for example, have found strategies to avoid crossing mountain ranges and skirt around such barriers (Bruderer & Jenni 1990).

Holarctic-breeding birds undertaking long distance migrations to the tropics follow three major migratory routes, the Nearctic-Neotropical (N-N), Western Palearctic-Afrotropical (WP-A) and Eastern Palearctic-Oriental (EP-O) flyways. The potential barriers that may affect migration vary considerably across the three flyways.

On the N-N flyway, the Gulf of Mexico and the Caribbean Sea are the only substantial barriers between the north temperate and tropical regions. Birds can avoid or minimise the length of these ocean crossings either by flying west, following the Mexican coastline, or by travelling southeast along the West Indies Island chain (Dorst 1962). Mountain ranges in the New World run from north to south and are thus not an obstacle for migrating birds (Dorst 1962).

Birds moving south from the Western Palearctic to tropical and sub-tropical Africa potentially have to negotiate the Alps, the Mediterranean and the Sahara or Middle Eastern Desert. The Alps, the Mediterranean and the Sahara all lie on a west-east axis, resulting in migratory routes that avoid the direct southward path (Bruderer 1997). Many Eurasian species have evolved migratory divides, avoiding these barriers by either flying west across the Straits of Gibraltar or east around the eastern edge of the Mediterranean (Berthold 1993).

For birds moving from the Eastern Palearctic to winter in the Indian subcontinent, the Tibetan Plateau and the Himalayas present formidable barriers (Chesser, 1994). Birds moving from the Eastern Palearctic towards South East Asia and Australia also face water crossings through Indonesia. Asian migrants cannot avoid the ocean crossing to Indonesia by flying around it and must thus fly over the South China Sea or avoid crossing completely.

On the WP-A and EP-O migration routes there is strong congruence between the bird families that undertake migrations, and in many cases the same species migrate on both flyways. The very different physical conditions encountered by birds migrating south from the Western and Eastern Palearctic could have a major influence on the non-breeding dispersion of these species. Similarly, the cumulative influence of numerous water barriers in South East Asia may be more of an obstacle to many migrating species than is the land barrier of the Sahara. It is highly likely that ecological barriers will affect different groups of birds in different ways.

Apart from the Australian endpoint, the Asian migration system, especially of land birds, has been much less studied than its Afrotropical and Neotropical counterparts (Curry-Lindahl 1981, Rappole 1995). Very few Palearctic-breeding land birds migrate to Australia (Blakers *et al.* 1984), although such migrants are well represented at equivalent latitudes in both the Neotropics (Rappole 1995) and the Afrotropics (Fry *et al.* 1986-1997). Dispersal barriers in the east may thus prevent species from optimising their migratory end-points.

Bergmann's rule states that widely distributed homeotherms tend to be larger in colder climates (Ives & Barry 1974, Begon *et al.* 1996). Larger birds have a low surface area to body mass ratio and thus require a proportionally smaller increase in metabolic energy to compensate for colder ambient temperature than do small birds (Aschoff 1981). Root (1988 a,b) argued that the temperate limits to species' wintering ranges are constrained by their ability to tolerate low ambient temperatures. Repasky (1991) challenged this premise on the basis that species of all sizes are found at high latitudes. Both Root's (1988 a,b) and Repasky's (1991) findings were based on N-N flyway. However, little is known about the weight distribution of migrants on the WP-A and EP-O flyways.

Aims and objectives

This chapter aims to quantify the breeding and wintering ranges of Holarctic-breeding migrant land birds on the N-N, WP-A and EP-O flyways, and to compare patterns of attenuation in taxon richness on the non-breeding grounds across the three flyways.

Specifically, the following hypotheses are tested:

- Taxon richness (TR) is influenced by a combination of land area and distance from the breeding grounds. TR will decrease both with decreasing land area and with increasing migration distance.
- The rate of taxon attenuation (decrease in taxon richness) on the N-N and EP-O flyways is more rapid than on the WP-A flyway as a result of peninsula effects and water crossings.
- Not all bird species are equally affected by dispersal barriers.
- Taxa whose non-breeding ranges are centred in the tropics are, on average, smaller than those migrating to more temperate regions (Bergmann's rule).

METHODS

Establishing the data set

The world can be classified into biogeographical regions, themselves formed by physical barriers to dispersal of terrestrial plants and animals (Cox & Moore 1993,

MacDonald 2003). Numerous different boundaries have been proposed to delineate these regions (MacDonald 2003). For example, several different lines have been proposed to separate the Oriental and Australian regions (MacDonald 2003), the most famous being Wallace's line (Cox & Moore 1993, MacDonald 2003). However, in this study the Oriental region is defined as including Wallacea, New Guinea and the Australian region (Table 1.1). In analyses where Australia is excluded, the EP-O flyway is referred to as EP-O (-Au). The remainder of the divisions used in this study are summarised in Table 1.1.

Table 1.1: Definition of terms used to describe the three major migratory flyways.

Term	Definition
N-N	<p>Nearctic-Neotropical flyway</p> <p>Nearctic = North America, Canada & Alaska (north of 30°N) Neotropics = Central America, the West Indies and South America (south of 30°N)</p>
WP-A	<p>Western Palearctic-Afrotropical flyway</p> <p>Western Palearctic = Palearctic west of 70°E and north of 30°N Afrotropics = area south of 30°N and west of 70°E</p>
EP-O	<p>Eastern Palearctic – Oriental flyway</p> <p>Eastern Palearctic = Palearctic east of 70°E and north of 30°N Orient = India (east of 70°E), China, the Thai-Malay Peninsula, Indonesia and Australia (south of 30°N)</p>

Lists of all migratory species using the N-N, WP-A and EP-O flyways were extracted from appendices 1, 2 and 3 in Rappole (1995) (Appendix 1). Only strictly terrestrial species - those species with no obligatory ties to inland or coastal waters - were included. Species lists were ordered following Monroe & Sibley (1993), and were modified to include subspecies recognised by Monroe & Sibley (*op. cit.*), thus producing a list of all taxa following each of the three major migratory routes. Taxa within the genus *Phylloscopus* were further modified following Irwin *et al.* (2001). The total number of migrant taxa on each flyway is: 243 N-N taxa, 145 WP-A taxa and 241 EP-O taxa.

Taxon lists contain those migrants having all or part of their breeding ranges north of 30° N, and at least part of their wintering ranges south of 30° N. This list thus includes all taxa with discrete breeding and wintering ranges (full migrants) and most partial migrants, but excludes species that undertake only local or altitudinal migration. Taxa classified as partial migrants are those with overlapping breeding and non-breeding ranges. For taxa with two discrete populations with different behaviours, each population was recorded separately.

Both the northern and southern limits of the breeding and non-breeding ranges for each taxon on each flyway were determined from the literature (Appendix 2). The land area per 5 degree latitude band (south of 30°N) was determined along each flyway using a geographic projection map of the world (Arcview GIS 3.2a, 1992-2000). The presence/absence of taxa across the West Indies islands and the Philippine/Indonesian islands was determined from the literature, allowing identification of those taxa that definitely make ocean crossings. Populations of Yellow Wagtail *Motacilla flava* visiting Indonesia were treated as one taxon, because the presence/absence of subspecies on each of the islands is inadequately known. In some cases on the N-N flyway, for taxa not wintering on any of the West Indian islands, it was difficult to determine whether they made ocean crossings through the Gulf of Mexico or whether they followed the Central American land bridge. Mean body mass was extracted from Dunning (1993) and other sources and divided into three categories: ≤30g (small); 31-100g (medium); and, > 100g (large) (Appendix 2).

Data analysis

The influence of geography on taxon richness (TR)

Migrant TR on each of the three flyways was analysed as a function of land area (km² per 5° latitude band), latitude (distance from the breeding grounds i.e. from 30°N) and dispersal barriers. TR and land areas were regressed against one another, as were TR and latitude. Rates of migrant taxon attenuation were compared across the three flyways using a Kolmogorov-Smirnov two-sample test (based on taxon numbers per 5° latitude band). The average distance flown (distance between the mid-latitude of the breeding range and the mid-latitude of the non-breeding range) on each flyway was compared using a Kruskal-Wallis one-way ANOVA. The relative southerly penetration of taxa that occur

on both the WP-A and the EP-O migration system (Afro/Asian taxa) was compared using a T-test for matched-pairs.

Geography and leapfrog migration

For each taxon on each flyway, northern (breeding) and southern (non-breeding) range limits were regressed against one another to test for the existence of leapfrog migration (those breeding farthest north migrate farthest south) on the three flyways.

Body mass and latitude

On all three flyways, body mass was analysed as a function of latitude (based on the percentage of taxa in each body mass category occurring in each 5° latitude band). Latitudes where less than 10 migrant taxa were present were excluded. All statistical analyses were performed using STATISTICA 6 (2002), Sokal & Rohlf (1981) and Zar (1999).

RESULTS

The influence of geography on TR

On all three flyways, there was a strong negative correlation between distance from the breeding grounds and the number of migratory taxa present: N-N ($r = -0.90$, $p < 0.001$, $n = 17$); WP-A ($r = -0.97$, $p < 0.001$, $n = 13$); and EP-O ($r = -0.92$, $p < 0.001$, $n = 15$). Thus, taxon attenuation occurs on all three flyways irrespective of the presence or absence of migration barriers. There was a significant difference between the rate of taxon attenuation on the WP-A and N-N flyways ($D = 0.570$; $p < 0.025$), but not between taxon attenuation rate on the WP-A and EP-O flyways ($D = 0.467$; $p > 0.05$) or the N-N and EP-O flyways ($D = 0.290$; $p > 0.1$). The N-N and EP-O flyways were the most similar, with a rapid decrease in TR between 25°N and the Equator, followed by a more gradual decrease in TR further south (Fig. 1.1).

On the N-N flyway, land area is least between 30° N and 10° N, increasing farther south in South America (Fig. 1.1a). Land area on the EP-O flyway decreases rapidly between 30° N and 5° N before increasing in the Indonesian islands and further south in Australia (Fig. 1.1c). On the WP-A flyway, land area south of 30°N decreases steadily from north to south (Fig. 1.1b).

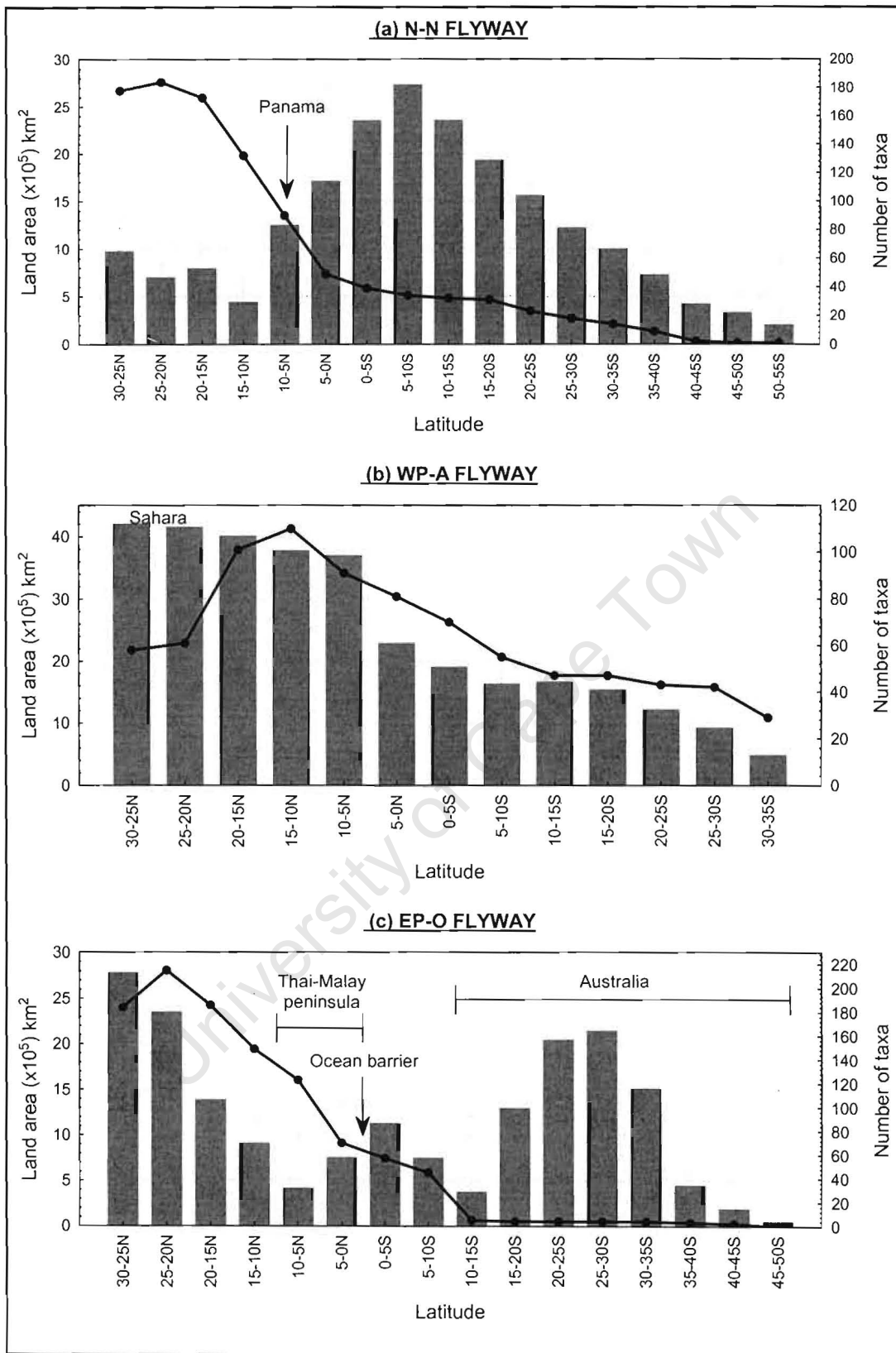


Figure 1.1: Land area available per 5° latitude band (*bars*) compared with the total number of migrant taxa present per 5° latitude band (*lines*) on the (a) N-N, (b) WP-A and (c) EP-O flyways.

On the WP-A flyway there was a strong positive correlation ($r = 0.73$, $p < 0.005$, $n = 13$; Fig. 1.1b) between land area and the number of migrant taxa present. This relationship was even stronger ($r = 0.96$, $p < 0.001$, $n = 11$) if the Sahara ($30^{\circ}\text{N} - 20^{\circ}\text{N}$) was excluded. However, on the WP-A flyway, there was also a strong negative correlation between land area and distance from the breeding grounds ($r = -0.97$, $p < 0.001$, $n = 13$). By contrast, there was no correlation between land area and TR on either the N-N (Fig. 1.1a) or EP-O (Fig. 1.1c) flyways. On both the N-N and EP-O flyways, TR decreased rapidly with the reduction in land area in the tropics but did not increase with increasing land area further south. Taxa that migrate on both the WP-A and EP-O flyways travelled significantly further south in the Afrotropics than in the Orient ($t = -6.63$, $df = 46$, $p < 0.001$; Fig. 1.2). Only 6 Afro/Asian taxa made ocean crossings to the Philippines and Indonesian islands.

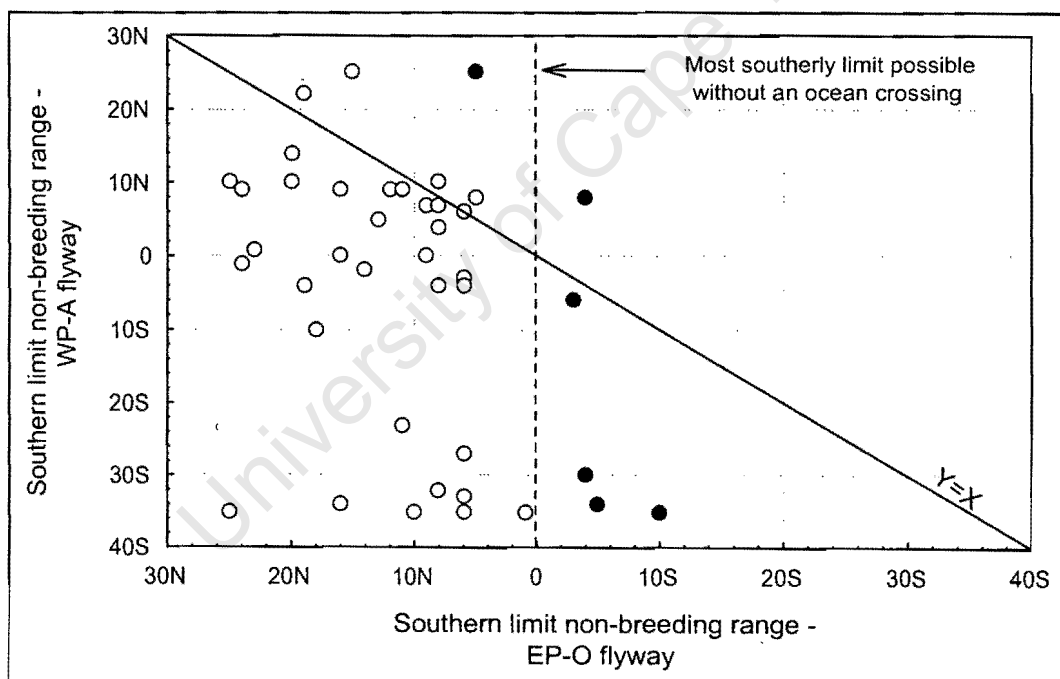


Figure 1.2: Comparison of the southern limits of migrants present on both the WP-A and EP-O flyways. Points falling below the line of $Y=X$ represent taxa that migrate farther south in the Afrotropics than in the Orient. Solid symbols indicate those EP-O taxa that make ocean crossings.

There was a significant difference ($H = 58.63$, $p < 0.001$, $N = 629$) in average migration distance (mid latitude of the breeding grounds to mid latitude of the non-breeding grounds) on the three flyways. The average migration distance, in degrees of latitude, on the WP-A flyway (34.56 ± 18.25 SD) was greater than on either the N-N (21.94 ± 17.05 SD) or the EP-O (22.82 ± 12.16 SD) flyway.

There is a steady decrease in TR among taxa moving south through Central America and also among taxa that “island-hop” through the Caribbean, moving south across the island chain of the Bahamas, and through the Greater and Lesser Antilles (Fig. 1.3). This decrease in TR is, however, more gradual along the Central American mainland. On the N-N flyway, 154 taxa (63% of the total) make no water crossings through the Caribbean. This includes many taxa that breed in the Western Nearctic and thus do not need to migrate over water. At least 89 taxa do undertake ocean crossings. Fifty-four of these are present on at least one of the West Indian islands and the other 35 taxa cross either the Gulf of Mexico, Caribbean Sea, Atlantic Ocean or Pacific Ocean to reach South America (Fig. 1.3).

On the EP-O flyway, the majority of taxa (173, 74%) also make no water crossings. These include taxa that terminate their migrations north of the Indonesian islands or west of *ca* 98° E. Of these, only 11 (6%) terminate their migration on the Thai-Malay Peninsula. Sixty-one taxa (26%) make ocean crossings to one or more of the Indonesian islands (Fig. 1.4). As is the case in New World, there is a rapid reduction in TR across the island chains leading towards Australia. Only 10 and 11 taxa reach Papua-New Guinea and Timor, respectively. Of these, only four continue across the Torres Strait and/or the Timor Sea to northern Australia (Fig. 1.4).

Geography and leapfrog migration

On both the WP-A and N-N flyways there were significant correlations ($r = -0.34$, $p < 0.001$, $n = 145$, Fig. 1.5a; $r = -0.25$, $p < 0.001$, $n = 243$, Fig. 1.5b, respectively) between the northern limit of the breeding range and southern limit of the non-breeding range, indicating widespread interspecific leapfrog migration. This pattern was even stronger when only full migrants were included in the analyses (N-N, $r = -0.35$, $p < 0.001$, $n = 140$; WP-A, $r = -0.44$, $p < 0.001$, $n = 114$). There was no such relationship on the EP-O flyway (Fig. 1.5c).

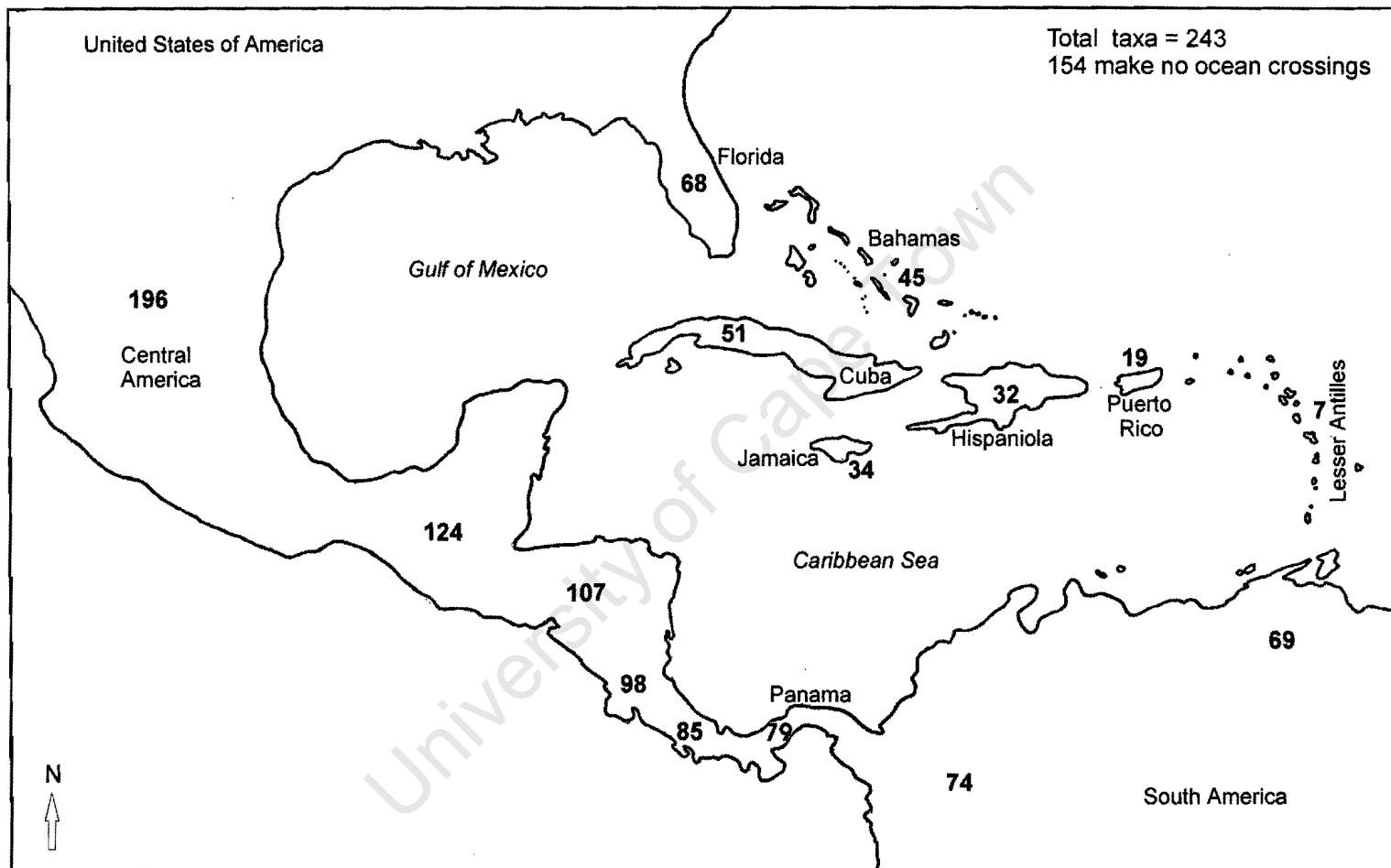


Figure 1.3: Map of Central America and the West Indies showing taxon richness on the mainland and on different islands and island groups.

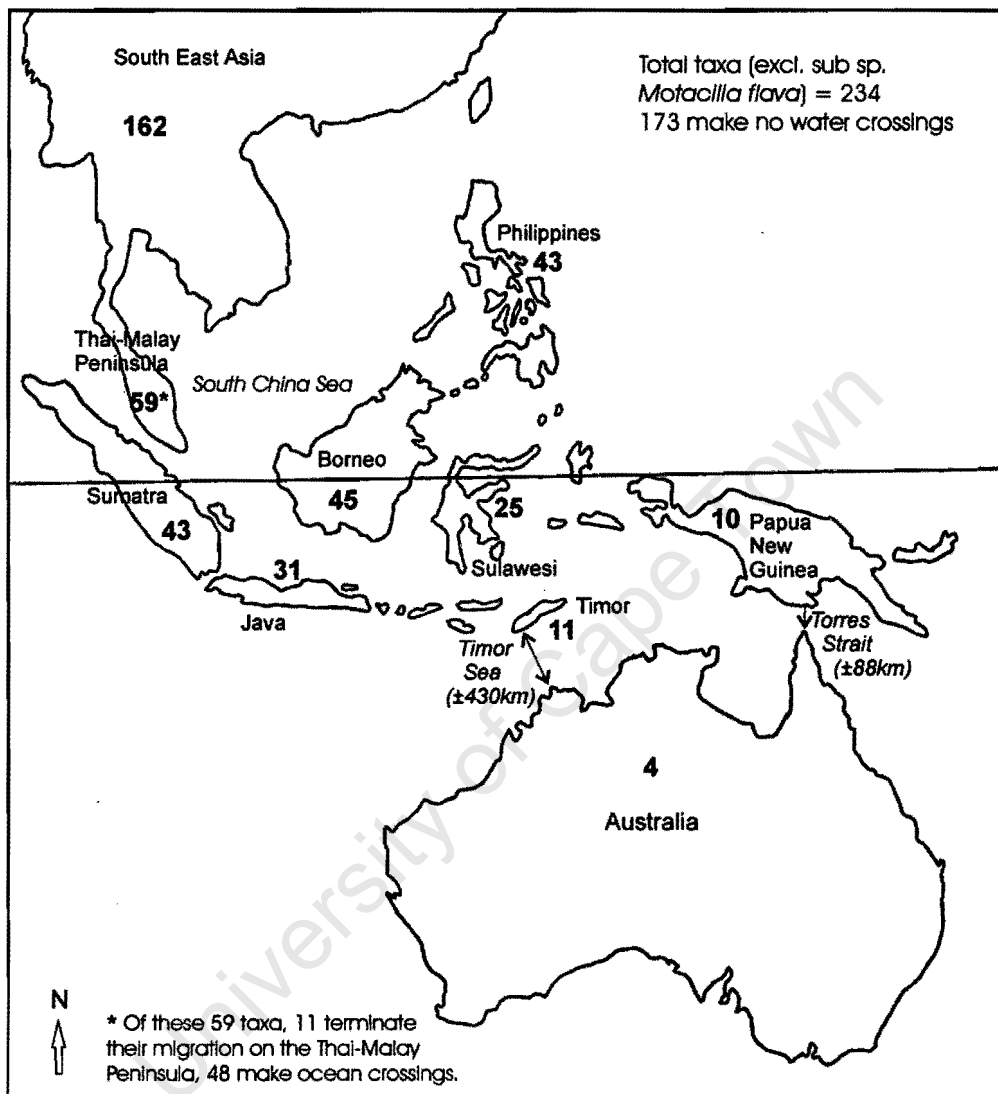


Figure 1.4: Map of South East Asia and Indonesia showing taxon richness on different islands and island groups

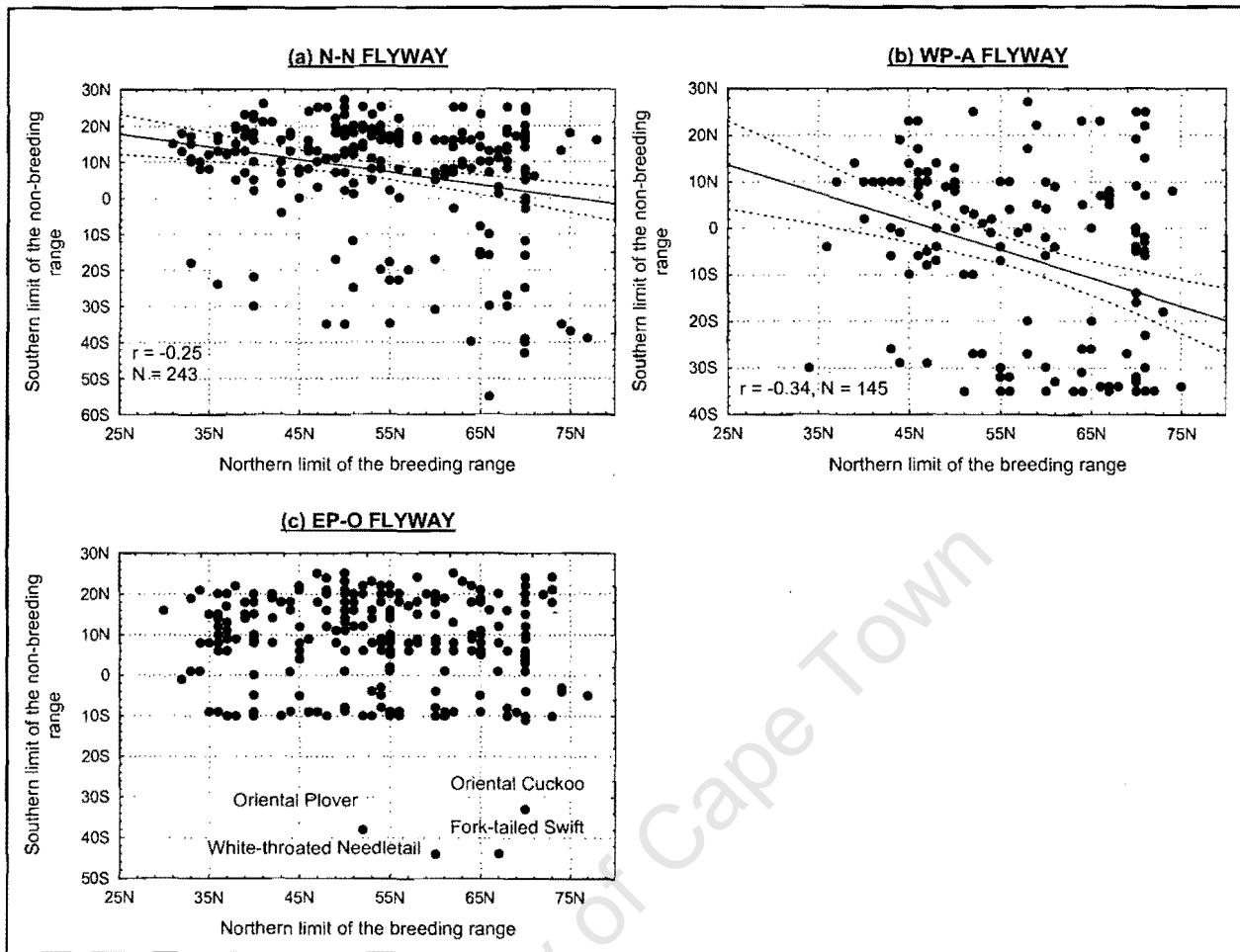


Figure 1.5: Relationships between the northern limit of the breeding range and the southern limit of the non-breeding range for (a) the WP-A flyway, (b) the N-N flyway and (c) the EP-O flyway.

Body mass and latitude

Birds of all sizes were present at all latitudes. However, small birds (<30g) tended to be centred around the tropics, while larger birds showed a tendency to winter further north or south at temperate latitudes (Fig. 1.6). On the WP-A flyway, there were far more small birds present in the most northerly latitude bands (temperate regions) than on the EP-O and N-N flyways.

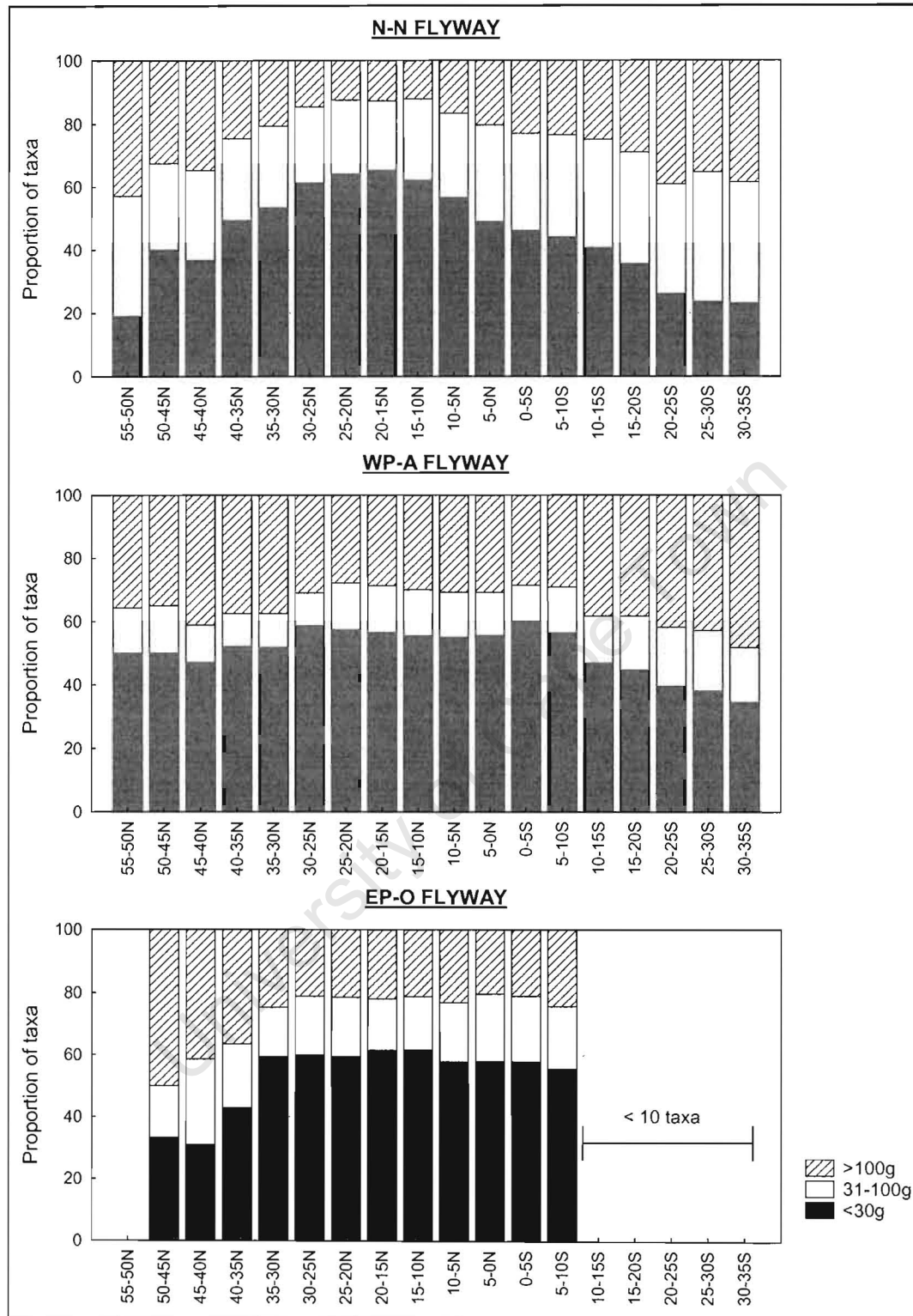


Figure 1.6: Latitudinal variation in migrant body size (as a proportion of all taxa in each 5° latitude band occurring in each of three size categories). Latitude bands with less than 10 migrant taxa were excluded.

DISCUSSION

There are substantial differences in the geography of the N-N, WP-A and EP-O flyways, both in terms of land area as a function of latitude and the presence and nature of barriers that may affect migration. In the WP-A migration system, the land area of the wintering grounds is greater than the land area of the breeding grounds from which the migrants are drawn. On the EP-O migration system, the situation is reversed, with the source area in the Eastern Palearctic being far larger than the receiving area in the Orient. On the N-N migration system, the breeding and non-breeding ranges are similar in size. When considering the non-breeding ranges on the three flyways, there is considerably more land available south of 30° N on the WP-A flyway ($3.20 \times 10^7 \text{ km}^2$) than on the N-N ($2.06 \times 10^7 \text{ km}^2$), EP-O ($1.85 \times 10^7 \text{ km}^2$) and EP-O (-Au) ($1.04 \times 10^7 \text{ km}^2$) flyways.

There are far more partial migrants on the N-N flyway than on the WP-A and EP-O flyways. On the latter flyways, west-east orientated geographical barriers provide natural “breaks” between breeding and non-breeding ranges (Chesser, 1994). The Mediterranean Sea, for example, forms a barrier between the breeding and non-breeding ranges of many taxa on the WP-A flyway. The fact that many N-N migrants have partially overlapping breeding and wintering ranges may be a consequence of the lack of such barriers lying at right angles to the migratory pathway. There is also a greater proportion of migrants with the northern limits of their wintering ranges between 60°N – 30°N on the WP-A flyway than on the N-N and EP-O flyways. This might be the result of Europe having milder winter temperatures than the Nearctic and Eastern Palearctic at equivalent latitudes (The Times Atlas of the World 1993), enabling taxa to remain further north during the winter. The annual temperature range (and hence amplitude of change in seasonal food supplies (Newton & Dale 1996 a,b) is also much less in Europe than at equivalent latitudes in Nearctic and Eastern Palearctic (The Times Atlas of the World 1993).

There are considerable differences in the rate of taxon attenuation across the three flyways (Fig. 1.1). These differing rates of taxon attenuation and differences in southward penetration of migrants may be a response to latitude, land area, dispersal barriers, habitat limitation, evolutionary history, or a combination of these.

The influence of geography on TR

The patterns of TR attenuation in relation to latitude were similar on the N-N and EP-O flyways, with a rapid decrease in TR between 25°N and the Equator followed by a more gradual decline further south (Fig. 1.1). In the Afrotropics, taxon attenuation is more gradual and many more taxa migrate further south on the WP-A flyway than on the N-N and EP-O flyways (Fig. 1.1). This is the likely result of greater continuous land area available to migrants on their African wintering grounds.

On the N-N, WP-A and EP-O flyways, migrant TR decreased with increasing distance from the breeding grounds, irrespective of the presence or absence of migration barriers (Fig. 1.1). These findings are consistent with those of Rappole (1995) for the Neotropics and Newton (1995) for the Afrotropics. However, it is unlikely that latitude *per se* is the ultimate cause of this pattern, being merely a surrogate measure for ecological factors that may influence migration (Lack 1954, MacArthur 1959, Herrera 1978, Terborgh 1989, Newton & Dale 1996 a,b).

The southward decrease in land area per 5° latitude band is more gradual on the WP-A flyway than on the EP-O and N-N flyways (Fig. 1.1). On the EP-O flyway, there is an abrupt decrease in available land area south of 20° N as a result of the constricting Thai-Malay Peninsula and the fragmentation of the Indonesian archipelago (Fig. 1.1c). On the N-N flyway, Middle America and the West Indies provide only a small receiving area for wintering Neotropical migrants (Fig. 1.1a).

On the N-N flyway, there was no relationship between TR and land area (Fig. 1.1a). There was a rapid decrease in TR between 25°N and 5°N, corresponding with the constriction of Central America. There was a further rapid decrease in TR between 5°N and the Equator in the vicinity of the Isthmus of Panama. Taxon numbers did not increase with the increasing land area of South America.

On the EP-O flyway, there was also no relationship between land area and migrant TR (Fig. 1.1c). There was a rapid decrease in TR between 25°N and 0°, corresponding with the land area bottleneck created by the Thai-Malay Peninsula. Between 0° and 15°S, through the Indonesian Islands, the number of migrant taxa decreased with decreasing land area. South of 15°S land area increases (Australia), but there was no corresponding increase in migrant taxon richness. The failure of most migrants to reach Australia could result from a) the land area bottleneck, b) their inability to cross either the Timor Sea or the Torres Strait or c) a lack of suitable resources (habitat or food) in Australia. Thus, on

the N-N and EP-O flyways, the influence of distance from the breeding grounds on TR is of overriding importance.

On the WP-A flyway, the number of migrant taxa present per 5° latitude band decreased with decreasing land area (Fig. 1.1b). However, between 30°N and 20°N, taxon numbers were low in comparison to those on the N-N and EP-O flyways at the same latitudes. These latitudes correspond to the Sahara Desert. Most of the taxa present at these latitudes occur in the Nile valley or on the Arabian Peninsula. On the WP-A flyway, there was a strong relationship between land area and TR as well as distance and TR. However, on the WP-A flyway, land area availability is auto-correlated with distance, with land area being greater closest to the breeding grounds.

Terrestrial taxa present on both the WP-A and EP-O flyways penetrate farther south in the Afrotropics than in the Orient (Fig. 1.2), providing further support for the hypothesis that the constricting Thai-Malay peninsula and /or ocean crossings prevent taxa from optimising their migratory end-points. Several of these taxa belong to the families Accipitridae and Falconidae, taxon groups that avoid ocean crossings. Only 6 Afro/Asian migrant taxa wintering in the Orient make an ocean crossing, the remainder all winter north of the ocean barrier (i.e. north of the Equator).

On average, terrestrial taxa migrating to the Neotropics and the Orient travel similar distances to reach their wintering grounds: birds migrating to wintering grounds in the Afrotropics travel much further. This may be the result of the constricting land areas in Central America and the Thai-Malay Peninsula acting as filters that are bypassed by relatively few taxa.

Ocean crossings apparently form barriers to the majority of terrestrial migrants on both the EP-O and N-N flyways. However, on both these flyways several taxa that make no water crossings do have congeners that migrate across oceans to Indonesia and the West Indies respectively.

On the N-N flyway, 63% of migrant taxa make no water crossings through the Caribbean, travelling south following the Central American mainland. These include pigeons and doves, many hummingbirds, flycatchers, towhees and New World warblers. Many of these taxa breed in the Western Nearctic and thus do not need to migrate over water. These birds are, however, still faced with the constriction effect of the narrow land bridge formed by Costa Rica and Panama. At least 37% of terrestrial migrant taxa on the N-N flyway make ocean crossings, be they short crossings between the mainland and one or more islands, or larger journeys over either the Atlantic or the Pacific Oceans (Fig. 1.3).

On the N-N flyway, the number of migrant taxa present in the West Indies decreases steadily from northwest to southeast across the island chain (Fig. 1.3). The incidence of migrants drops off rapidly towards the east, from 51 in Cuba to 19 in Puerto Rico and seven in the Lesser Antilles. Strong prevailing northeasterly trade winds at those latitudes, at the time of southward migration, may limit the number of migrants crossing from the Greater to the Lesser Antilles (Terborgh & Faaborg 1980). Despite this clear pattern, however, the geography of this Archipelago is such that the larger islands are closer to the North American mainland, thus making separation of the influences of distance and island area on TR nearly impossible (Terborgh & Faaborg 1980). There is also a steady decrease in TR moving south through Central America, corresponding with a decrease in available land area. However, the decrease in TR is more gradual through Central America than across the West Indies, suggesting that the cumulative influence of ocean crossings has a stronger effect on TR than does the constricting land area.

Along the mainland of the N-N flyway there is a rapid attenuation in TR in the vicinity of the Isthmus of Panama. This could be as a result of a) the peninsula itself causing a bottleneck effect, b) habitat, c) the presence of (potentially competing) austral migrants or d) evolutionary history. Geological history indicates that North and South America were once separated by open sea and only became joined by a land bridge 3.5 million years ago (MacDonald 2003). This may explain why many migrant taxa terminate their migration in Panama, even though today there is no obvious physical barrier to further southward movement.

On the EP-O flyway, 74 % of migrants (173 taxa) do not make ocean crossings and hence do not penetrate south of 2°N (Singapore). These include many eagles, orioles, drongos, buntings and warblers. Of these 173 “landbound” taxa, all but 11 end their journeys north of the Thai-Malay Peninsula (or east in India) (Fig. 1.4). This is the likely result of the limited land area available and/or the land area bottleneck, preventing more taxa from reaching this point. A total of 61 taxa on the EP-O flyway make successful ocean crossings to one or more of the Indonesian islands (including the Philippines) (Fig. 1.4). Of these, 48 also occur on the Thai-Malay Peninsula, which, being the southernmost extension of continental Asia, forms a natural flight path for migrants that converge here before spreading further south to the Indonesian Archipelago. There are a total of 59 taxa on the Thai-Malay peninsula.

The number of migrant taxa present on the Indonesian islands decreases with increasing distance from the Asian mainland, irrespective of island size. Of the 61

migrants that do make ocean crossings and reach one or more of the Indonesian islands, only 10 reach Papua New Guinea and 11 reach Timor. These taxa complete numerous ocean crossings to reach these islands, but only four continue across the Torres Straits (\pm 88 km) or the Timor Sea (\pm 430 km) to Australia. Of the four terrestrial taxa that do reach Australia, the White-throated Needletail (*Hirundapus caudacutus*) and Fork-tailed Swift (*Apus pacificus*) follow the shortest route, across the Torres Straits. The Australian distributions of the Fork-tailed Swift, Oriental Cuckoo (*Cuculus saturatus saturatus*) and the Oriental Plover (*Charadrius veredus*) suggest that some (or most in the case of the Oriental Plover) of these birds arrive in Australia from the Lesser Sunda Islands, crossing the 430 km stretch of water from Timor to the Australian mainland (Blakers *et al.* 1984).

Land constrictions and ocean crossings appear to have a stronger effect on the distribution of migrants in the Orient than in the Neotropics. The reason for this may be a simple geographical one. On the EP-O flyway the island chains lie south of the mainland and there is no land bridge available to bypass ocean crossings. On the N-N flyway, the island chain lies further north, and the option exists (albeit at the cost of increased distance) for migrants to avoid the Caribbean and travel south through the Central American mainland.

Why do so few migrants reach Australia?

Of the Palearctic taxa that reach Papua New Guinea, only 20% continue across the Torres Strait to Australia, despite the fact that they have already completed much larger single ocean crossings. Many more taxa migrate between Australia and Papua New Guinea (Blakers *et al.* 1984) than between the Palearctic and either Papua New Guinea or Australia. The paucity of species migrating to Papua New Guinea and Australia could be an 'historical legacy' of the break-up of Gondwanaland. Australia and Papua New Guinea are tectonically linked and are close to one another. However, 130 mya they were several thousand kilometres south of Indonesia (Cox & Moore 1993, MacDonald 2003). This, however, does not explain why such a large proportion of migrants terminate their journeys in Papua New Guinea. Failure to reach Australia may be linked to the country's geological history. The habitat available in Australia is very different to the forests of Indonesia, and species may avoid Australia as a result of a lack of suitable habitats (Chapter 2). However, many of the species that reach Papua New Guinea occupy habitats other than forests. Australia is very nutrient-poor and food supplies may be insufficient for migrants to deposit sufficient fuel reserves to embark on a long northward migration. It

also has a very seasonal climate and resident species do not breed in the wet season at the time when the few boreal migrants are present, suggesting that food availability is low at this time of the year (R. Noske in litt.). By contrast, many southern African species do breed during the wet season when boreal migrants are present (Hockey 2000).

Geography and Leapfrog migration

The term “leapfrog migration” refers to the tendency for populations to redistribute themselves in winter in a pattern forming a mirror image of their breeding distributions (Bell 1996); i.e. taxa breeding further north have a more southerly non-breeding range than those breeding at lower latitudes. Leapfrog migration occurs on both the N-N and WP-A flyways (Fig. 1.5). This pattern was most pronounced on the WP-A flyway, where there are no major geographical barriers to migration and no land constrictions on the non-breeding grounds. There was no such relationship between breeding and non-breeding ranges on the EP-O flyway (Fig. 1.5c). The lack of leapfrog migration in the Orient provides additional, indirect support for the land area bottleneck and/or the existence of ocean crossings forming a barrier to southward movement.

Body mass and latitude

On all three flyways, approximately 60% of all migrants weigh less than 30g. There is a greater proportion of large migrants (>100g) on the WP-A flyway compared with the N-N and EP-O flyways (Fig. 1.6). This is a result of the WP-A flyway having a greater proportion of Accipitridae and Falconidae than the other flyways.

There is a tendency for small birds to winter in and around the tropics while many large migrants winter at more temperate latitudes (Fig. 1.6). This could be considered analogous to the findings of Root (1988 a,b), namely that in the non-breeding season, northern limits to the ranges of migrant taxa are constrained by their tolerance of low temperatures. However, what is interesting here is that the pattern is symmetrical about the Equator, with the proportion of small birds decreasing south into the temperate latitudes (Fig. 1.6). This pattern cannot be interpreted under Bergmann’s Rule alone, because temperatures at south temperate latitudes at the time migrants are present (i.e. Austral summer) are high. Irrespective of the tendency of smaller birds to be centred around the tropics, birds of all sizes are present at all latitudes as was shown by Repasky (1991). Repasky (1991) challenged Root’s idea on the basis that species of all sizes are found at all latitudes. Golden-crowned Kinglets *Regulus satrapa*, for example, are one of the

smallest migrant birds but remain as far north as 62°N during the winter. They prefer dense coniferous woodlands (Kaufman 1996), which presumably buffer extreme temperatures to some degree (Askin 1983, Chesser & Levey 1998).

On the WP-A flyway, a large proportion of small birds were present at north temperate latitudes compared to equivalent latitudes on the N-N and EP-O flyways at equivalent latitudes (Fig. 1.6). The mean January temperatures (boreal winter) in Europe are milder than at equivalent latitudes in the Nearctic and Eastern Palearctic (The Times Atlas of the World 1993), enabling small birds (favouring warmer temperatures - Bergmann's Rule) to remain further north in Europe during winter than in North America or the Eastern Palearctic.

Overview: Regional patterns or global paradigms?

Longitudinal variation in the geography of the world varies considerably, and this influences migration systems. Along each of the three flyways different migratory patterns have arisen in response to physical factors including latitude, land area and dispersal barriers. Distance from the breeding grounds was of overriding importance in predicting TR across the non-breeding grounds on all three flyways. Indeed, the pattern of decreasing TR with increasing distance from the breeding grounds is the only convincing pattern repeated across all three flyways (Table 1.2). On the WP-A flyway, there was a strong relationship between land area and migrant taxon attenuation (Table 1.2). This was not the case in N-N or the Orient as a result of land area bottlenecks and the presence of ocean barriers. However, in the Afrotropics area is auto-correlated with distance from the breeding grounds, thus it is not surprising that on the WP-A flyway a relationship exists between land area and TR on the non-breeding grounds. The lack of ocean barriers in Africa south of 30°N allows a greater proportion of WP-A taxa to penetrate further south in the Afrotropics than in the Neotropics and the Orient (Table 1.2).

It appears that the cumulative influence of many water barriers in South East Asia and the West Indies proves more of an obstacle to migration than does the land barrier of the Sahara in Africa (Table 1.2). Furthermore, the ocean barriers on the EP-O flyway have a greater effect on migrant taxa than those on the N-N flyway. In the Orient the water crossing to Indonesia cannot be avoided and taxa must either fly non-stop over the ocean or avoid crossing completely. However, on the N-N flyway, taxa can avoid an ocean crossing by following the land bridge of Central America. Water barriers have a great effect on terrestrial migratory taxa, but it is difficult to predict individual taxon responses.

At the extremes, many raptors - primarily vultures and eagles - do not undertake an ocean crossing because the thermal updrafts on which they depend for energy efficient travel are weak and widely dispersed. Many of the Apodidae (swifts), by contrast, do make large ocean crossings. These birds spend their life on the wing and long, non-stop flights across water apparently pose little problem : two of the four migrants reaching Australia are swifts.

Table 1.2: Summary of the key patterns that exist on each flyway. Shaded blocks indicate paradigms that hold true across all three flyways, unshaded blocks represent regional specifics.

Potential influences on migration patterns	Pattern
Distance from breeding grounds	TR decreases with increasing distance from the breeding grounds.
Land area (non-breeding grounds)	WP-A = TR increases with increased area N-N, EP-O = no relationship between TR and land area
Constricting peninsulas and ocean barriers	Affect southward penetration of N-N and EP-O migrants.
Leapfrog migration	N-N, WP-A = leapfrog migration exists EP-O = no leapfrog migration
Body mass	Small birds centred around the tropics: Large birds winter further north and south at temperate latitudes.

Leapfrog migration was evident on the N-N and WP-A flyways; however, many migratory species on the EP-O flyway seem to be prevented from reaching their optimal migratory end-points (Table 1.2). This appears to be a result of the land area bottleneck and ocean crossings acting as barriers to migration.

Species with non-breeding ranges centred in the tropics are, on average, smaller than those moving to more temperate regions on all three flyways (Table 1.2). However, these trends provide a limited predictive capacity of migrant distribution because birds of all body weights are found at all latitudes (Fig. 1.6).

The very different physical conditions encountered by Holarctic-breeding birds on each of the three flyways strongly influences the migration patterns and non-breeding distribution of these taxa. The trend of decreasing TR with increasing distance from the breeding grounds is repeated globally across all three flyways. However, information on distance from the breeding grounds alone has little predictive precision because the availability of continuous land area, and the presence/absence and nature of ocean barriers also strongly influences TR on the non-breeding grounds.

University of Cape Town

Chapter 2

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CHAPTER 2

Distribution patterns and habitat

INTRODUCTION

Several independent studies have concluded that there is a strong link between low winter temperatures and the proportion of migrant taxa in a community (e.g. Herrera 1978, Newton & Dale 1996 a,b, Chesser 1998). Thus, it could be predicted that if low temperatures, acting either directly or indirectly, promote migratory behaviour, environmental features that buffer temperature extremes would themselves influence migration (Hockey, in press).

In general, increased buffering is associated with increased habitat complexity. For example, forests are more buffered from temperature extremes and are less seasonally variable in food supply than are less buffered habitats such as shrublands or grasslands (Askin 1983, Chesser & Levey 1998). Many studies (e.g. Croat 1975, Stiles 1978, Smythe 1982, Feinsinger *et al.* 1988, Levey 1988, Blake & Loiselle 1991) have shown that edge, open and canopy habitats in the Neotropics are more temporally and spatially variable in their resource supply than is forest understory. This is probably due to the fact that the understory experiences less fluctuation in wind, rain and sunlight (Bilcke 1984, Fetcher *et al.* 1985, 1994).

At both the regional scale (Herrera 1978, Bilcke 1984, Beehler *et al.* 1986, Chesser 1994, Mills 2000) and at the global scale (within the family Cuculidae; Hockey 2000), the proportion of migrant species increases along a gradient of decreasing habitat complexity from forest and woodland to scrub and open country. In an analysis of 13 Neotropical families, those occupying “unbuffered habitats” (forest edge and canopy, secondary and open habitats) were most likely to be migratory while families occupying buffered forest interiors were more likely to be resident (Chesser & Levey 1998). Within the Afrotropics, Palearctic-breeding migrants favour open habitats while residents favour woodlands and forests (Hockey 2000).

A major difference across the world’s migratory systems is the relative availability of different habitat types to potential migrants during both the breeding and non-breeding seasons: this is predicted to have some influence on habitat occupancy. Most Austral-Neotropical passerine migrants, for example, breed in open and scrub habitats (Chesser

1994), the commonest habitat in temperate South America. On the other hand, the majority of Nearctic-Neotropical migrants breed in the extensive woodlands and forests of North America (Karr 1976a, Mönkkönen *et al.* 1992, Chesser 1994). Similarly, the majority of Palearctic-Afrotropical migrant land birds spend the non-breeding season in open, savanna-like habitats, the most extensive habitat type of the region (Lövei 1989, Lack 1990, Hockey 2000).

Assuming that migrants occupy similar habitats in their breeding and non-breeding ranges, Bilche (1984) proposed that the proportion of migrants in the breeding ranges is determined by the occurrence and geographic distribution of different vegetation types in their wintering quarters. Numerous studies (e.g. Hutto 1985, Pearson 1978, Fitzpatrick 1980, Curry-Lindahl 1981, Brosset 1984, Greenberg 1984, Chesser 1994) have shown that many species do indeed occupy wintering habitats that resemble their breeding habitats, although there are also exceptions to this generalisation (Rappole *et al.* 1983, Robbins *et al.* 1989, Petit 1991).

Similar proportions of migrants breed in forests and woodlands on all three flyways: 112 (35%) N-N migrants, 107 (32%) EP-O migrants and 64 (25%) WP-A migrants (Rappole 1995). There is however, a striking difference between the numbers of migrant species using forests and woodlands on their wintering grounds across the three flyways (Rappole 1995). Most N-N and EP-O migrants that breed in forests and woodlands winter in the same habitats (Rappole *et al.* 1993, Rappole 1995). By contrast, the WP-A non-breeding grounds are characterised by a low diversity of forest-dwelling migrants (Moreau 1952, Karr 1976 a,b, Mönkkönen *et al.* 1992), with only 13 species (7%) wintering in forest habitats in Africa (Rappole 1995, based on Moreau 1972). Many WP-A migrant passerines that breed in temperate forests inhabit savannas in Africa (Mönkkönen *et al.* 1992, Rappole 1995). Rappole (1991) proposed that the apparent avoidance of forest habitats by WP-A migrants was because of a lack of forested stopover habitats between temperate Europe and the tropics.

The EP-O migration system is less well known than the N-N and the WP-A systems. However, based on the presence of a greater proportion of forest on the N-N and EP-O flyways compared to the WP-A flyway, a similar pattern of habitat occupancy in the Neotropics and the Orient could be predicted. Many EP-O migrants do occupy forested habitats on their wintering grounds (Rappole 1995), but the generality of this pattern has not been well explored.

Numerous studies have compared species' habitat occupancy within and between specific habitat categories (e.g. forest or open country). However, despite the intuitive importance of habitat availability, I am unaware of any study that quantifies habitat occupancy as a function of habitat availability.

Aims and Objectives

This chapter aims to quantify habitat occupancy in the breeding and wintering ranges of all migrants on the N-N, WP-A and EP-O flyways, and to compare patterns across these three flyways. The aim is to determine to what extent habitat availability influences habitat occupancy and whether or not certain habitat types are favoured or avoided.

The following hypotheses are tested:

- As a result of the considerable global variation in the availability of different habitat types, habitat occupancy during the breeding and non-breeding seasons will differ across the three flyways.
- Habitat availability on the wintering grounds will influence migrant taxon richness over and above the influence of land area and latitude (i.e. TR and habitat diversity will be positively correlated).
- Habitat occupancy by taxa using both the African and Asian flyways (referred to as Afro/Asian taxa) will not differ.
- Breeding habitats will, for most taxa, be similar to wintering habitats on all three flyways.

METHODS

Establishing the data set

Taxon lists were compiled as for Chapter 1. The breeding and wintering habitats occupied by all migrant taxa present on each of the three flyways were determined from the literature (Appendix 2). Four habitat categories were recognised and only the primary habitat occupied by each taxon was considered, except for those species considered to be genuine habitat generalists.

Habitat categories linked to individual bird species were:

WB = Well-buffered habitats (closed habitats such as forests and closed woodlands in which the physical nature of the habitat dampens the effects of seasonal variation in climate).

MB = Moderately buffered habitats (savanna, scrub, shrub and brush habitats). This also includes the transition zone between forests and grasslands.

UB = Habitats with little or no buffering from seasonal climate extremes (open habitats such as grasslands, deserts, semi-deserts, tundra, and many types of agriculture).

D = Diverse; used by habitat generalists and usually including 2-3 of the above categories.

These categories are broad and it is essential to stress that ecological boundaries are rarely as distinct as this classification implies.

The available area of each habitat type, north and south of 30°N, was determined for each flyway. This was done in Arcview GIS 3.2a, using a geographic projection map of the World Biomes in WWF's Terrestrial Ecoregions of the World (1995-2003). Their 14 terrestrial biomes were classified into the three main habitat categories; well-buffered, moderately buffered and unbuffered.

Data analysis

In all analyses, habitat availability was compared north and south of 30°N, the latitude used as the division between the Holarctic and the subtropics. For all habitat availability comparisons, habitat availability was recorded to the most northerly (breeding range) and the most southerly (non-breeding range) 5° latitude band in which at least one taxon was present during the breeding or non-breeding season respectively (Fig. 2.1). However, on the N-N and EP-O flyways, very few taxa penetrated to the most northerly and southerly latitudes respectively (Fig. 2.1). For this reason, habitat availability analyses were repeated, for the N-N and EP-O flyways, excluding latitude bands containing fewer than 10 taxa.

Breeding habitat comparisons

Habitat availability on the breeding grounds was compared across the three flyways using a chi-squared test for independent samples. The same test was used to compare breeding habitat occupancy across the three flyways. Habitat generalists (i.e. those taxa in the 'diverse' habitat category) were included. Breeding habitat occupancy

was further compared with breeding habitat availability, excluding habitat generalists. These habitat generalists make up only a small proportion of the migratory assemblages: 9.5% of Nearctic taxa, 16% of Western Palearctic taxa and 14% of Eastern Palearctic taxa. The habitat selectivity of taxa on the breeding grounds of each flyway was calculated using Jacob's (1974) modification of Ivlev's Electivity Index, $E_i = (p_i - q_i) / (p_i + q_i - 2p_i q_i)$ where $p_i = N_i / N_t$ and $q_i = A_i / A_t$. N_i is taxon richness in the i^{th} habitat, N_t is the taxon richness in all three habitats combined, A_i is the area of the i^{th} habitat and A_t is the total area. E_i ranges from -1 to $+1$, with positive values indicating preference and negative values indicating avoidance of a particular habitat. The index has no statistical power.

Non-breeding habitat comparisons

Non-breeding habitat availability and habitat occupancy were compared across the three flyways in the same way as for the breeding grounds. On the non-breeding grounds, habitat generalists (excluded in comparisons between habitat availability and habitat occupancy) made up 11% of N-N taxa, 12% of WP-A taxa and 13% of EP-O taxa. Few land bird taxa use more than one flyway, and almost all that do so use the two Old World flyways. A Chi-squared test was used to test whether non-breeding habitat occupancy of Afro/Asian taxa differed between the Afrotropics and the Orient. A Chi-squared test was also used to compare non-breeding habitat choice of Afro/Asian taxa in the Orient with habitat choice of exclusively EP-O taxa.

Comparing breeding and non-breeding habitat availability and occupancy

Habitat availability in the breeding season was compared with habitat availability in the non-breeding season across all three flyways using a Chi-squared test for independent samples. Breeding habitat occupancy was similarly compared with wintering habitat occupancy on all three flyways: habitat generalists were included.

All statistical analyses were performed using STATISTICA 6 (2002) and Zar (1999).

RESULTS

Setting northern and southern limits for analyses

On the WP-A flyway, more than 10 taxa occur at the extremes of the breeding and non-breeding ranges, thus all latitudes were included in all analyses (Fig. 2.1b). On the N-N flyway there was no significant difference in habitat availability on either the breeding

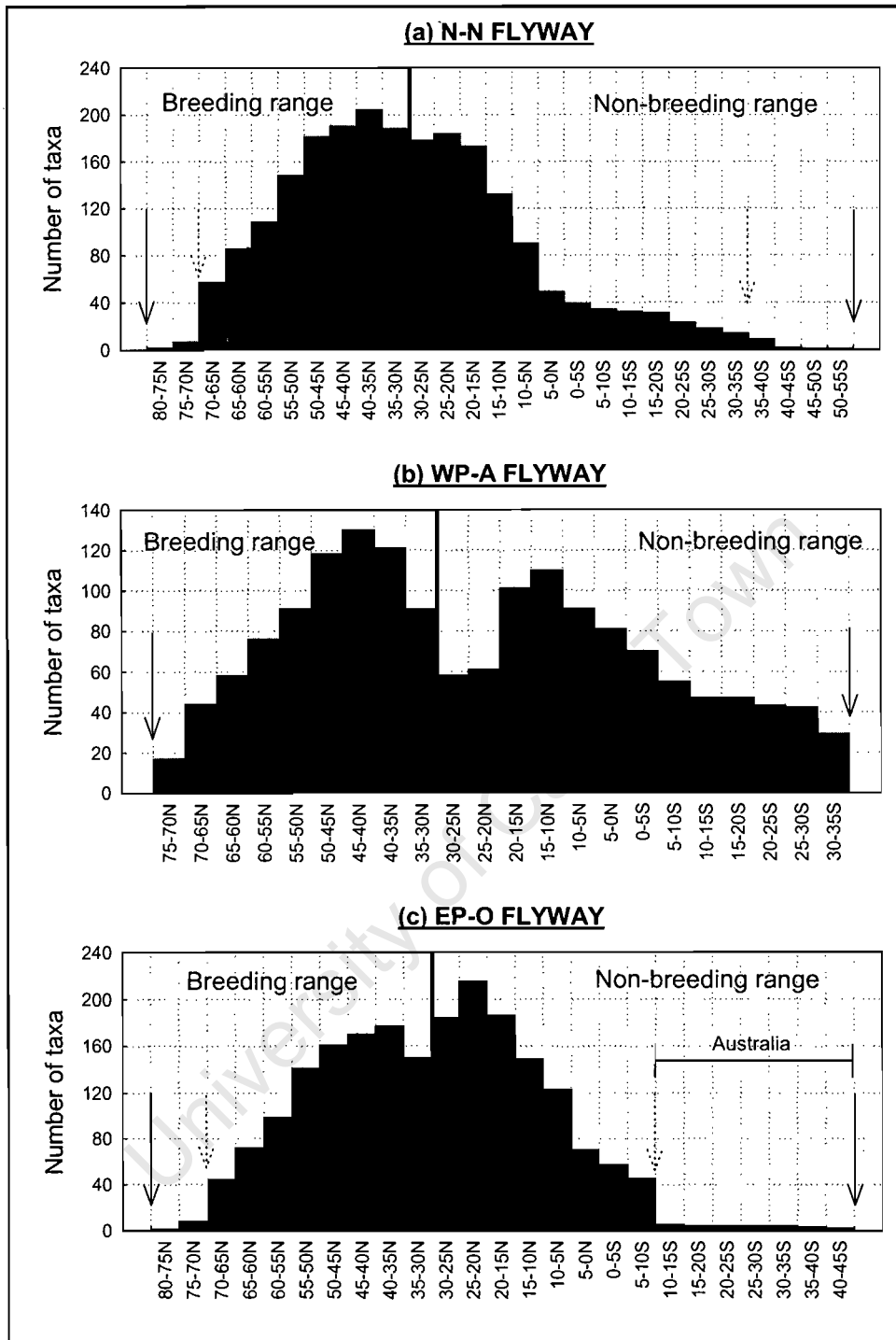


Figure 2.1: Total numbers of migrant taxa present per 5° latitude band in the breeding and non-breeding ranges on the (a) N-N, (b) WP-A and (c) EP-O flyways. (—) indicates the northern and southern limits of migratory taxa. (----) indicates latitudes above which taxon richness is less than 10.

or the non-breeding grounds whether ranges included or excluded 5° latitude bands where fewer than 10 taxa occur (Figs 2.1a, 2.2a). Breeding habitat availability on the EP-O flyway was also similar, regardless of which range limits were used (Figs 2.1c, 2.2b). However on the EP-O non-breeding grounds there was a highly significant difference ($\chi^2 = 32.7$, $p < 0.001$, $df = 2$) in habitat availability depending on whether high southern latitudes were included or excluded (Fig. 2.2b). Excluding those latitudes where fewer than 10 taxa spent the non-breeding season, there was a considerably greater proportion of well-buffered habitats available to EP-O (-Au) migrants than if the predominantly unbuffered habitats of Australia were included (EP-O (+Au); Fig. 2.2b). Most migrants fail to reach Australia (Chapter 1), thus this large landmass could be considered unavailable to EP-O migrants. Therefore, all habitat availability analyses on the EP-O flyway were repeated both including and excluding Australia. Range limits set for analyses were thus N-N, 80°N-55°S; WP-A, 75°N-35°S; EP-O (+Au), 80°N-45°S and EP-O (-Au), 80°N-10°S (Fig. 2.1).

Breeding habitat comparisons

There was a significant difference between the proportion of different breeding habitats available on the three flyways ($\chi^2 = 20.06$, $p < 0.001$, $df = 4$). The main differences were between the Nearctic and the Western Palearctic ($\chi^2 = 10.35$, $p < 0.001$, $df = 2$), and between the Western and Eastern Palearctic ($\chi^2 = 15.02$, $p < 0.001$, $df = 2$; Fig. 2.3a). There was, however, no significant difference between breeding habitat availability in the Nearctic and Eastern Palearctic: on both flyways, approximately 50% of the breeding habitats available are well buffered (Fig. 2.3a).

There were also significant differences in breeding habitat occupancy, irrespective of availability, across all three flyways ($\chi^2 = 80.56$, $p < 0.001$, $df = 6$): Nearctic vs. Western Palearctic ($\chi^2 = 59.27$, $p < 0.001$, $df = 3$); Western Palearctic vs. Eastern Palearctic ($\chi^2 = 57.87$, $p < 0.001$, $df = 3$); and, Nearctic vs. Eastern Palearctic ($\chi^2 = 18.25$, $p < 0.001$, $df = 3$). Migrants breeding in the Nearctic and Eastern Palearctic occupied mainly well-buffered habitats while those in the Western Palearctic occupied primarily unbuffered habitats (Fig. 2.3a).

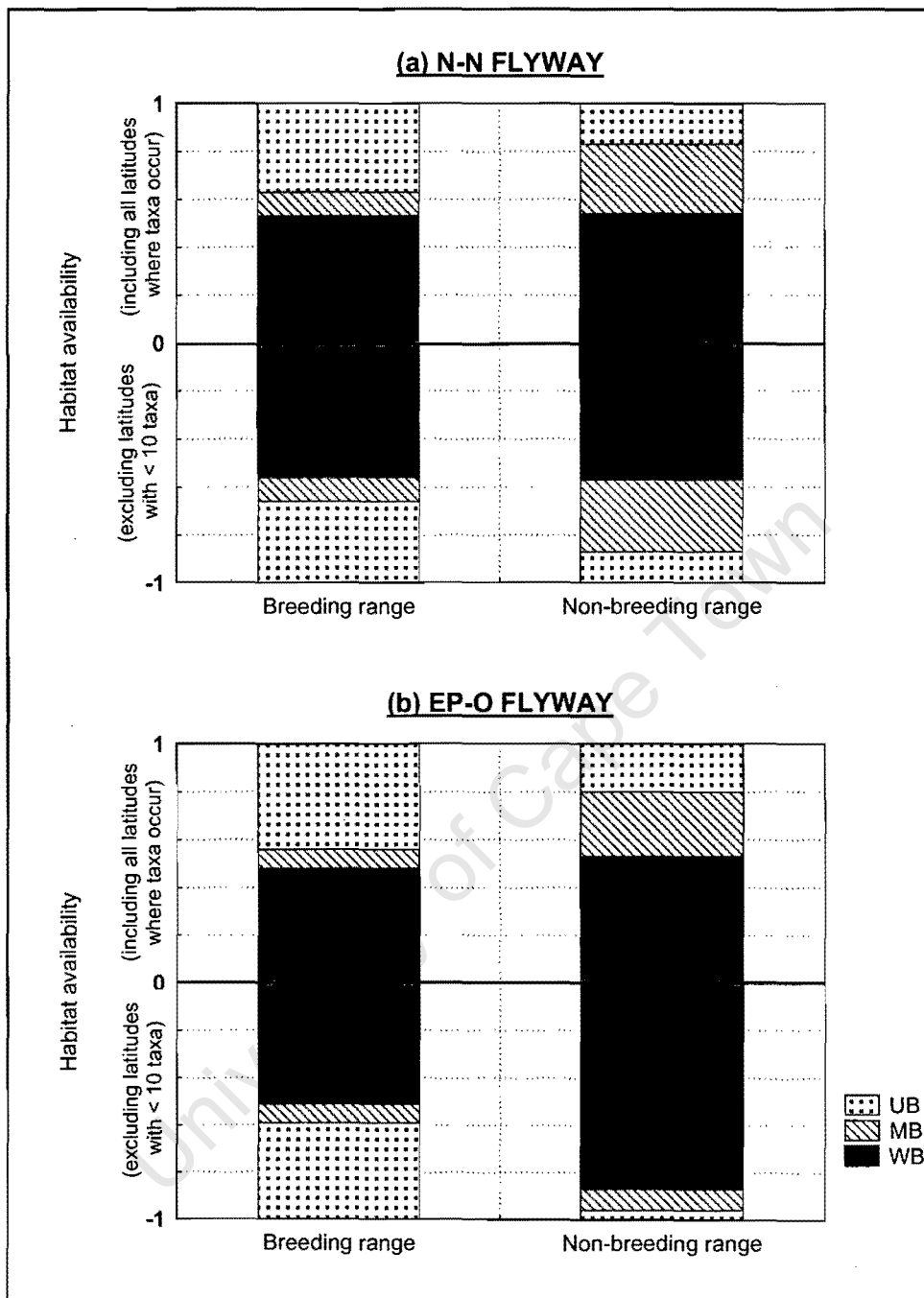


Figure 2.2: Comparison of habitat availability, using range limits corresponding to the highest latitudes where migratory taxa occur, with habitat availability when excluding latitudes where < 10 taxa occur. Breeding and non-breeding ranges are shown for (a) the N-N flyway and (b) the EP-O flyway. Habitat categories are: (WB) well-buffered, (MB) moderately buffered and (UB) unbuffered.

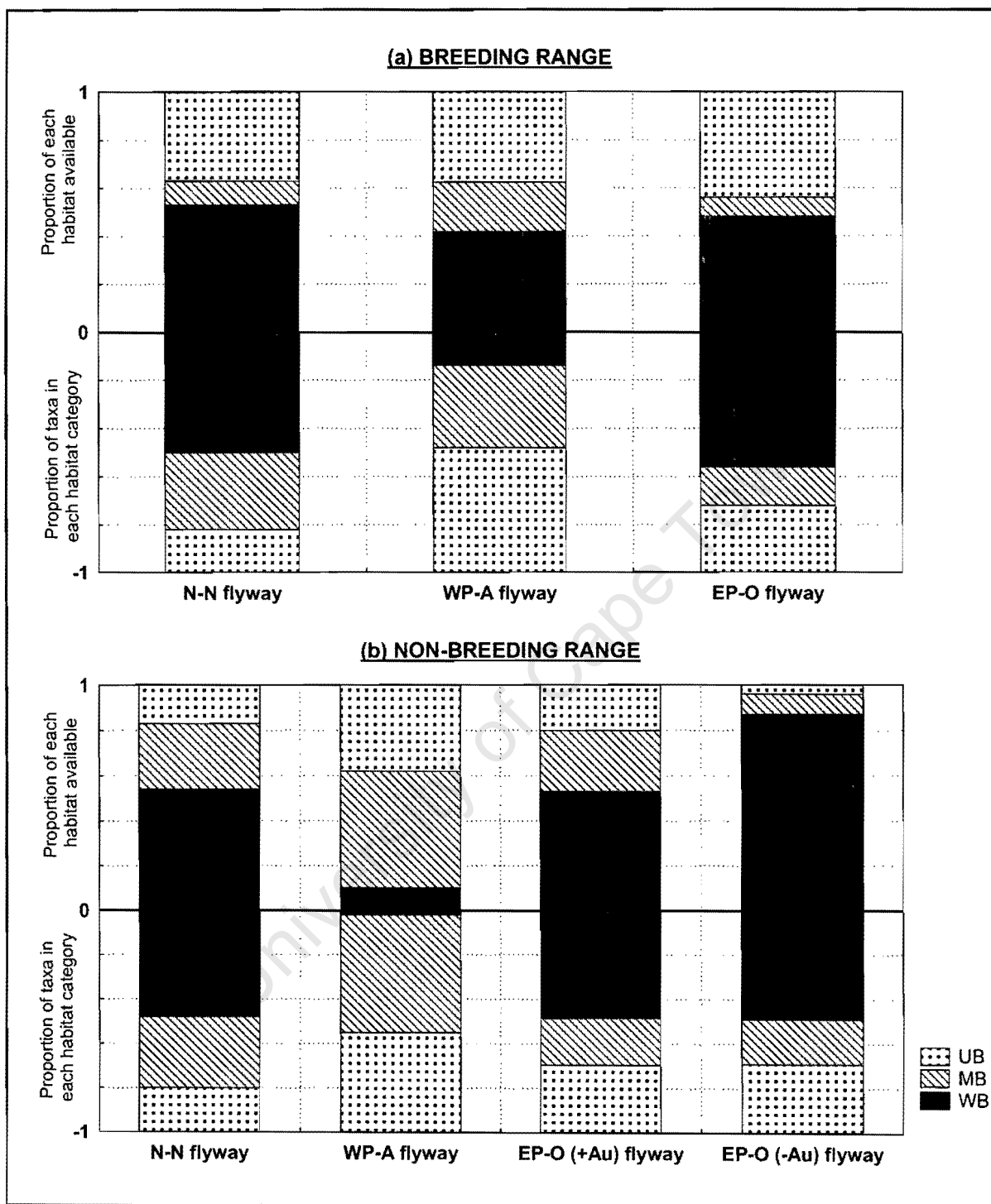


Figure 2.3: Comparison of habitat availability and habitat occupancy in well-buffered (WB), moderately buffered (MB), and unbuffered (UB) habitats on a) the breeding and b) the non-breeding grounds.

Breeding habitat availability and breeding habitat occupancy differ significantly on all three flyways (Fig. 2.3a); Nearctic, $\chi^2 = 37.10$, $p < 0.001$, $df = 2$; Western Palearctic, $\chi^2 = 27.03$, $p < 0.001$, $df = 2$; and, Eastern Palearctic, $\chi^2 = 15.88$, $p < 0.001$, $df = 2$. In the Western Palearctic, migrants avoid readily available well-buffered habitats ($E_i = -0.63$, Table 2.1). In the Nearctic and Eastern Palearctic, migrants favour the (limited) moderately buffered habitats (Nearctic, $E_i = 0.63$; Eastern Palearctic, $E_i = 0.48$; Table 2.1).

Table 2.1: Selectivity index values for all taxa in each habitat category on the breeding (BR) and non-breeding (NBR) grounds on the N-N, WP-A, EP-O flyways. Also shown are the selectivity indices for Palearctic-breeding EP-O taxa that migrate to both the Afrotropics and the Orient (Afro/Asian taxa), and those that migrate exclusively to the Orient. Shaded blocks indicate selection or avoidance of habitats.

HABITAT CATEGORY	N-N flyway		WP-A flyway		EP-O flyway				
	BR	NBR	BR	NBR	BR	NBR			
						All taxa		Afro/Asian taxa	Exclusively EP-O taxa
						EP-O (+Au)	EP-O (-Au)		
WB	-0.06	-0.12	-0.63	-0.69	0.08	-0.08	-0.75	-0.97	-0.65
MB	0.63	0.07	0.34	0.02	0.48	-0.16	0.46	0.33	0.50
UB	-0.45	0.10	0.28	0.14	-0.32	0.28	0.83	0.97	0.70

Non-breeding habitat comparisons

As on the breeding grounds, there was a significant difference between non-breeding habitat available on the three flyways ($\chi^2 = 145.52$, $p < 0.001$, $df = 4$). Significant differences in habitat availability on the non-breeding grounds exist between the Afrotropics and both the Neotropics ($\chi^2 = 119.99$, $p < 0.001$, $df = 2$), and the Orient (including Australia, $\chi^2 = 109.92$, $p < 0.001$, $df = 2$; excluding Australia $\chi^2 = 219.21$, $p < 0.001$, $df = 2$; Fig. 2.3b). There are considerably more open and savanna-like habitats available on the non-breeding grounds of the WP-A flyway compared with the other two flyways. When considering the most southerly range limits (including latitude bands with fewer than 10 taxa), there was no difference between habitat availability in the Neotropics

and the Orient (Fig. 2.3b). In both cases, well-buffered habitats were most available. However, when excluding Oriental latitudes with fewer than 10 taxa, there was a significant difference ($\chi^2 = 30.87$, $p < 0.001$, $df = 2$) between habitat availability in the Neotropics and the Orient (excluding Australia) (Fig. 2.3b). A considerably greater proportion of well-buffered habitat is available to EP-O (-Au) migrants than to N-N migrants.

There was a significant difference ($\chi^2 = 96.02$, $p < 0.001$, $df = 6$) between habitat occupancy, irrespective of availability, across the three flyways. There were highly significant differences in winter habitat occupancy between the Afrotropics and both the Neotropics ($\chi^2 = 78.07$, $p < 0.001$, $df = 3$) and the Orient ($\chi^2 = 83.55$, $p < 0.001$, $df = 3$; Fig. 2.3b). The difference between the Neotropics and the Orient was also significant ($\chi^2 = 10.16$, $p < 0.025$, $df = 3$) but not so strongly (Fig. 2.3b). As a generalisation, most N-N and EP-O migrants occupied well-buffered habitats while WP-A migrants occupied moderately buffered and unbuffered habitats (Fig. 2.3b).

There was no significant difference between habitat availability and habitat occupancy on the wintering grounds of the N-N flyway ($\chi^2 = 1.94$, $p > 0.05$, $df = 2$; Fig. 2.3b) and this was reflected in neutral habitat selectivity indices on this flyway (Table 2.1). On the WP-A flyway, there was a significant difference ($\chi^2 = 8.30$, $p < 0.02$, $df = 2$; Fig. 2.3b) between habitat availability and habitat occupancy on the wintering grounds, with migrants avoiding well-buffered habitats ($E_i = -0.69$; Table 2.1). On the EP-O (+Au) flyway, habitat availability and habitat occupancy differed significantly ($\chi^2 = 6.61$, $p < 0.05$, $df = 2$; Fig. 2.3b) even though the habitat selectivity indices were neutral (Table 2.1). When considering only those non-breeding latitudes where more than 10 taxa were present in the Orient (EP-O (-Au)), habitat occupancy differed even more significantly from habitat availability ($\chi^2 = 42.88$, $p < 0.001$, $df = 2$; Fig. 2.3b) with strong selection for unbuffered habitats ($E_i = 0.83$) and avoidance of well-buffered habitats ($E_i = -0.75$; Table 2.1).

Comparing wintering habitat occupancy of Palearctic-breeding Afro/Asian migrant taxa on the WP-A and EP-O flyways there was no significant difference in wintering habitat occupancy between flyways. However, there was a significant difference ($\chi^2 = 46.95$, $p < 0.001$, $df = 3$) in wintering habitat use between exclusively EP-O taxa and Afro/Asian taxa using the EP-O flyway (Fig. 2.4). More than 50% of exclusively EP-O taxa favoured well-buffered habitats (Fig. 2.4a) while Afro/Asian taxa favoured

unbuffered habitats (Fig. 2.4b, Table 2.1). This pattern of habitat choice most closely resembled these species' habitat choice in Africa (Fig. 2.4c), suggesting that their use of the WP-A flyway pre-dates their use of the EP-O flyway.

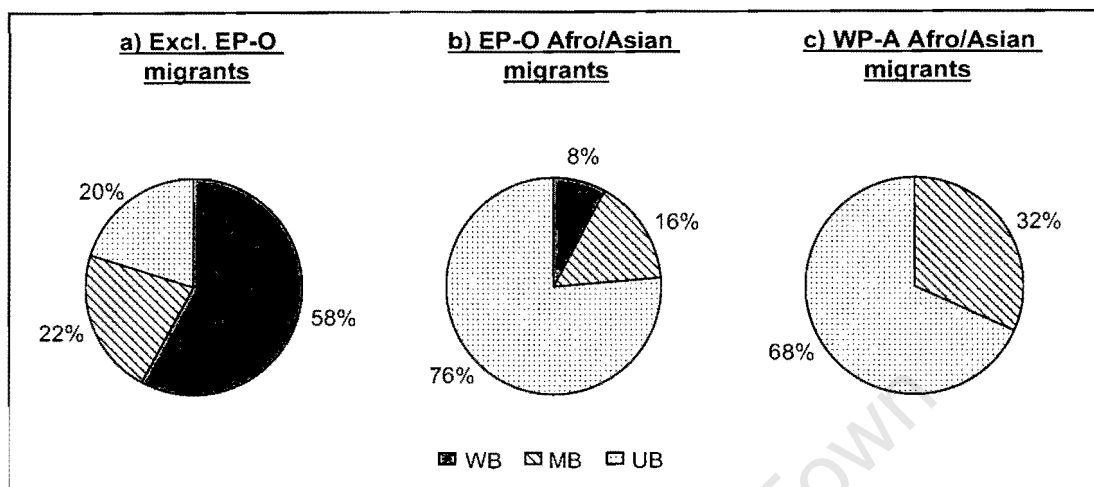


Figure 2.4: Habitat occupancy of (a) EP-O migrants wintering exclusively in the Orient, (b) Afro/Asian migrants wintering in the Orient, and (c) Afro/Asian migrants wintering in the Afrotropics.

Comparing breeding and non-breeding habitat availability and occupancy

There were significant differences between breeding and wintering habitat availability on all three flyways: N-N, $\chi^2 = 32.69$, $p < 0.001$; WP-A, $\chi^2 = 79.47$, $p < 0.001$; EP-O (+Au), $\chi^2 = 41.55$, $p < 0.001$; and EP-O (-Au), $\chi^2 = 51.53$, $p < 0.001$; all $df = 2$ (Fig. 2.3). There was no significant difference between breeding habitat occupancy and wintering habitat occupancy on either the N-N or the EP-O flyways i.e. migrants occupied similar habitats on their breeding and non-breeding grounds regardless of relative habitat availability (Fig. 2.3). Excluding habitat generalists, only 6% and 12% of N-N and EP-O migrants respectively switched habitat between breeding and non-breeding seasons. However, on the WP-A flyway there was a significant difference between habitat occupancy during the breeding and wintering seasons ($\chi^2 = 16.44$, $p < 0.001$, $df = 3$), with an increase in the number of taxa occupying moderately buffered habitats during the winter and a decrease in the number of taxa using well-buffered habitats (Fig. 2.3). Excluding habitat generalists, 22% of WP-A migrants switched habitats between the breeding and wintering grounds.

Overall differences and similarities between habitat availability and occupancy are summarised in Table 2.2.

Table 2.2: Comparisons of habitat availability and habitat occupancy for the breeding (BR) and non-breeding (NBR) ranges on each of the three flyways.

	N-N flyway	WP-A flyway	EP-O (-Au) flyway
BR	P < 0.001 Avoid UB Favour MB	P < 0.001 Avoid WB	P < 0.001 Favour MB
NBR	NS	P < 0.02 Avoid WB	P < 0.001 Avoid WB Favour UB

DISCUSSION

Breeding habitat comparisons

Proportional availability of different habitat types is similar in the Nearctic and the Eastern Palearctic, with approximately 50% of the habitat being well buffered (Fig. 2.3a). The Western Palearctic differs in having a smaller proportion of well-buffered habitat and a larger proportion of moderately buffered habitat (Fig. 2.3a). The relative availability of unbuffered habitats is similar in all three regions.

Breeding habitat occupancy differed considerably across the three flyways (Fig. 2.3a). In the Nearctic and Eastern Palearctic a large proportion of migrants occupied well-buffered habitats, while in the Western Palearctic the greatest number of migrants occupied unbuffered habitats with only a small proportion occupying well-buffered habitats (Fig. 2.3a).

Across all three flyways variations existed between breeding habitat availability and habitat occupancy (Fig. 2.3a). Although there was some difference between habitat availability and habitat occupancy on the breeding grounds of the Eastern Palearctic, this difference was not as pronounced as on the Nearctic and Western Palearctic breeding grounds. In the Eastern Palearctic, and even more so in the Nearctic, moderately buffered

habitats were favoured for breeding (Nearctic, $E_i = 0.63$; Eastern Palearctic, $E_i = 0.48$; Fig. 2.3a, Table 2.1). As a corollary, in these regions, a smaller proportion (Nearctic, 18%; Eastern Palearctic, 28%) of migrants occupy open habitats relative to their availability, 37 and 44% respectively (Fig. 2.3a). In the Western Palearctic, migrants avoid well-buffered habitats (used by 14% of taxa), despite this habitat type covering 42% of the breeding grounds (Fig. 2.3a, Table 2.1). This discrepancy between habitat availability and habitat occupancy indicates that habitat availability alone cannot explain habitat occupancy on the breeding grounds.

Non-breeding habitat comparisons

Including all latitudes, non-breeding habitat availability in the Orient (EP-O (+Au)) is similar to that in the Neotropics, with more than 50% being well buffered (Fig. 2.3b). However, considering only those latitudes where more than 10 taxa were present, the Orient (EP-O (-Au)) differs from the Neotropics. There is a considerable reduction in the proportion of moderately buffered and unbuffered habitats, and an increase in the proportion of well-buffered habitats available to EP-O (-Au) migrants (Fig. 2.3b). Most of southern China, the Thai-Malay Peninsula and Indonesia is forested, and almost 90 % of the land area available to migrants wintering in the Orient (excluding Australia) is covered by forest (Fig. 2.3b). Habitat available to migrant taxa wintering in the Afrotropics differed considerably from the Neotropics and the Orient. In the Afrotropics, the majority of habitat available is savanna (52%) and open (38%) habitats (Fig. 2.3b).

Reflecting this variability, the wintering habitats of migrants on each of the three flyways differed considerably (Fig. 2.3b). Migrants in the Neotropics and the Orient were the most similar, occupying mostly well-buffered habitats (Neotropics, 48%; Orient, 49%) during the non-breeding season. In the Afrotropics, very few migrants (2%) occupied well-buffered habitats, favouring the less buffered savannas and open habitats. These findings are consistent with those of Wells (1990), Rappole (1995), Hockey (2000), Balme (2001) who showed that species richness and species diversity (of both residents and migrants) are considerably higher in the forests of the Neotropics and the Orient than in Afrotropical forests. The paucity of forest dwelling taxa in the Afrotropics, relative to the Neotropics and Orient, could simply reflect the relatively limited amount of forest habitat available. Africa's vegetation changed as climate became progressively drier throughout the Tertiary and especially since the Pliocene (Axelrod & Raven 1978, van Zinderen Bakker & Mercer 1986). The moist tropical forest belt was progressively

narrowed, as savanna, thornscrub, grassland, semidesert and desert environments gradually encroached. The contraction of tropical forests in Africa caused the extinction of many taxa (van Zinderen Bakker & Mercer 1986), possibly explaining the limited number of both resident and migrant taxa found in tropical forests of Africa today. The lack of forest dwelling taxa has also been attributed to the lack of diversification in the Palmae and Lauraceae plant families, both of which contribute significantly to the diets of a wide range of birds in Neotropical and Oriental forests (Snow 1980).

On the Neotropical wintering grounds, there was no significant difference between habitat availability and habitat occupancy (Fig. 2.3b), with selectivity indices for taxa in each of the three habitats in the Neotropics being neutral (Table 2.1). In the Afrotropics, there was a substantial difference between habitat occupancy and habitat availability (Fig. 2.3b), with migrants avoiding (scarce) well-buffered habitats as they do on the breeding grounds (Table 2.1). This has been interpreted as a consequence of the lack of forested stop-over sites along migration routes into the Afrotropics (Rappole 1991). Considering all available land area on the EP-O (+Au) wintering grounds, there was a significant difference between habitat availability and habitat occupancy (Fig. 2.3b), although this pattern was not convincingly supported by habitat selectivity indices (Table 2.1). However, when excluding Australia (only four of 241 taxa penetrate that far south), the pattern changed. The majority (87%) of habitat available is well buffered but, only 48% of all migrant taxa wintering in the Orient (excluding Australia) occupy this habitat (Fig. 2.3b). Selectivity indices suggest that the strength of avoidance of forest habitats in the Orient (excluding Australia) ($E = -0.75$) is very similar to that in the Afrotropics ($E = -0.69$, Table 2.1). EP-O (-Au) migrants showed a preference for unbuffered habitats on their wintering grounds (Table 2.1) even though there is a limited availability of this particular habitat (Fig. 2.3b).

The tendency for EP-O (-Au) taxa to select unbuffered habitats may result from greater seasonal variability in resources available in these areas compared with well-buffered habitats (Chesser & Levey 1998). Given the preference of Oriental migrants for unbuffered habitats, it seems doubly strange that so few reach Australia, where such habitats are readily available. Whilst their southward penetration through the Indonesian archipelago may be influenced by physical geography (Chapter 1), the very extensive forest cover of the region could also act as a habitat barrier to southward movement (in the same way as lack of forested areas along the migration route might regulate the passage of forest-dwellers into the Afrotropics).

Interestingly, among Palearctic-breeding taxa that migrate to both the Afrotropics and the Orient, habitat choice in the Orient mirrors that of the Afrotropics rather than reflecting similar habitat occupancy to the remainder of the EP-O migrants (Fig. 2.4). Migrants using both the WP-A and EP-O flyways favoured unbuffered habitats in both the west and east (EP-O, $E = 0.97$; Table 2.1). However, selectivity indices still indicated a tendency for exclusively EP-O migrants to avoid well-buffered habitats ($E = -0.65$) and favour unbuffered habitats ($E = 0.70$, Table 2.1).

Most taxa present on both the WP-A and EP-O flyways occur in savannas and grasslands, habitats widespread in the Afrotropics but relatively rare in the Orient (Fig. 2.4). It is possible that these are taxa whose breeding ranges contracted south and west during the last glaciation (resulting in migration into Africa) and subsequently expanded east following the retreat of glaciers. In some species, e.g. the European Wheatear *Oenanthe oenanthe* even though part of their population breeds in the Eastern Palearctic, the entire population migrates to Africa (Dorst 1962). It is possible that some 'expansionist species' have subsequently evolved shorter migration routes into the Orient, but have done so at the potential cost of having to occupy a rare habitat type. The majority of these Afro/Asian taxa do not migrate south of Equator on the EP-O flyway, but are present at more southerly latitudes in Africa (Fig. 1.2). The relatively short eastern migration suggests that the forest belt of South East Asia may act as a habitat barrier.

Comparing breeding and non-breeding habitat availability and occupancy

There is a considerable difference in breeding and wintering habitats available to migrants on all three flyways (Fig. 2.3). On all three flyways, there is a greater proportion of moderately buffered habitat available to migrants on the non-breeding grounds. On the N-N and EP-O (+Au) flyways, there is considerably less unbuffered habitat available on the non-breeding grounds than on the breeding grounds. On the EP-O (-Au) flyway, there is a considerably greater proportion of well-buffered habitat and less moderately buffered habitat available on the non-breeding grounds than on the breeding grounds. On the WP-A flyway, there is a substantial reduction in the proportion of well-buffered habitat available between the breeding and non-breeding grounds.

Comparing breeding and wintering habitat occupancy on the N-N and EP-O flyways, breeding habitat occupancy was similar to wintering habitat occupancy (Fig. 2.3). These findings are analogous to the findings of Hutto (1985), Pearson (1978), Fitzpatrick (1980), Curry-Lindahl (1981), Brosset (1984), Greenberg (1984) and Chesser (1994), that

many species occupy wintering habitats that resemble their breeding habitats. On the N-N and EP-O flyways, and excluding generalists only 12 (6%) and 23 (12%) taxa respectively changed habitats between the breeding and non-breeding season. Of these, most (9 (75%) N-N taxa, 19 (83%) EP-O taxa) moved into less buffered habitats on their wintering grounds. Overall, habitat use by breeding birds on these two flyways better reflected habitat occupancy on the wintering grounds than habitat availability on the breeding grounds. Wintering habitats (where many species spend more than half the year) thus appear to play an important role in influencing breeding habitat occupancy (as proposed by Bilche 1984).

The WP-A flyway was different from the N-N and EP-O flyways because habitat occupancy differed between the breeding and non-breeding seasons (Fig. 2.3). On the WP-A flyway, 26 taxa (22% - excluding generalists) changed habitats between the breeding and wintering ranges. Fifteen (58%) of these taxa occupied less buffered habitats in the Afrotropics but 11 (42%) switched from occupying unbuffered habitats in the Western Palearctic to moderately buffered habitats in the Afrotropics. Notwithstanding this difference, the selectivity indices showed that on both the breeding and non-breeding grounds, WP-A migrants avoided well-buffered habitats. On both the breeding and wintering grounds, WP-A migrants occupied mainly moderately buffered and unbuffered habitats, the most extensive habitats available in the Afrotropics. This preference for unbuffered and moderately buffered habitats may be attributed to the prevalence of relatively open savanna habitats in sub-Saharan wintering areas (Bilche 1984) and the absence of forest habitats in north Africa that could provide potential stopover sites for migrating forest species (Rappole 1995). This preference for African grassland and savanna habitats may be influenced by historical factors. According to Moreau (1966) these African habitats are significantly older than 70 000 years in comparison with Central American grassland habitats that are thought to be more recent (Bennett 1968).

Thus, on the breeding grounds, habitat occupancy is not linked to breeding habitat availability alone, but is also influenced by habitat occupancy on the non-breeding grounds.

Overview: Regional patterns or global paradigms?

Substantial differences exist between habitat occupancy in the breeding and non-breeding seasons across the three flyways (Table 2.3). N-N and EP-O migrants occupy mainly well-buffered habitats, while on the WP-A flyway migrants occupied less buffered habitats. Although wintering habitat occupancy differed between WP-A migrants and EP-O migrants, those Palearctic-breeding taxa migrating to both the Afrotropics and the Orient occupied habitats in the Orient that mirrored habitat occupancy in the Afrotropics rather than patterns of habitat occupancy by exclusively EP-O migrants.

Table 2.3: Comparison of the differences and similarities in habitat occupancy and habitat availability across the three flyways.

		Different	Similar
Breeding	Habitat availability	N-N & WP-A WP-A & EP-O	N-N & EP-O
	Habitat occupancy	All	None
	Habitat availability vs habitat occupancy	All	None
Non-breeding	Habitat availability	N-N & WP-A WP-A & EP-O N-N & EP-O (-Au)	N-N & EP-O (+Au)
	Habitat occupancy	All	None
	Habitat availability vs habitat occupancy	WP-A EP-O (+Au) EP-O (-Au)	N-N
Breeding vs Non-breeding	Habitat availability	All	None
	Habitat occupancy	WP-A	N-N EP-O

It might be expected that these differences in habitat occupancy across the flyways are linked to the considerable global variation in habitat availability (Table 2.3). However, in the Northern Hemisphere, variation exists between habitat availability and habitat occupancy on all three flyways (Tables 2.2, 2.3). On both the Nearctic and Eastern Palearctic breeding grounds migrants favour moderately buffered habitats, with Nearctic migrants also avoiding unbuffered habitats (Table 2.2). By contrast, on the Western Palearctic breeding grounds migrants avoid well-buffered habitats (Table 2.2). Thus, breeding habitat availability is not the only factor influencing breeding habitat occupancy. The similarity in habitat occupancy between breeding and wintering grounds on the N-N and EP-O flyways (Table 2.3), strongly suggests that wintering habitat occupancy has some impact on breeding habitat occupancy. There is some variation between breeding habitat occupancy and wintering habitat occupancy on the WP-A flyway (Table 2.3), but on both the breeding and wintering grounds migrants clearly avoid well-buffered habitats (Table 2.2). This is probably a consequence of the limited amount of forested habitat available to migrants wintering in the Afrotropics, as well as the lack of forested stop-over-sites for WP-A migrants.

In the Southern Hemisphere, habitat occupancy was closely linked to habitat availability in the Neotropics (Tables 2.2, 2.3). Thus, migrant taxon richness on the Neotropical wintering grounds was influenced by habitat availability over and above the influences of land area and latitude. However, on the WP-A flyway, habitat occupancy differed from habitat availability, with migrant taxa avoiding the well-buffered habitats of the central and west African forests (Tables 2.2, 2.3). On the EP-O (-Au) flyway, there was a similar mismatch between habitat availability and habitat occupancy on the wintering grounds, with migrants avoiding well-buffered habitats and favouring unbuffered habitats (Tables 2.2, 2.3). Migrant taxa thus avoid well-buffered habitats on both of the Old World flyways, irrespective of the proportion of well-buffered habitat available. Globally, therefore, habitat availability alone is not a good predictor of habitat occupancy (Table 2.2).

In conclusion, there are no major patterns of habitat occupancy that are repeated across all three flyways. The considerable global variation in habitat results in each range (breeding and non-breeding) and each flyway displaying its own unique patterns. Physical geography (Chapter 1) plays a more important role in influencing wintering distributions than does habitat availability.

Chapter 3

University of Cape Town

CHAPTER 3

Diet and foraging mode: are patterns repeated across flyways?

INTRODUCTION

Food is a primary component of an ecological niche and consequently is likely to be a key influence on migratory behaviour (Rappole 1995). Various factors, including rainfall, temperature and habitat buffering, may influence food abundance (Lack 1954, MacArthur 1959, Herrera 1978, Terborgh 1989, Newton & Dale 1996 a,b), and seasonal fluctuations in food availability are likely to be a primary force driving migration across all geographical scales (Levey & Stiles 1992).

In the temperate Northern Hemisphere the arrival of summer produces an abundance of food and long hours of daylight during which to obtain it, a critical factor for birds feeding young (Dingle 1996). The very marked seasons of the temperate north support a large temporary population of breeding birds in summer, but diminishing food supplies in winter force many birds to migrate south towards areas with more favourable environmental conditions. The food of some species may become much scarcer in winter, while food supplies of others may become completely unavailable, locked by ice in soils and water (Newton & Dale 1996b). The amplitude of this seasonal variation in food availability, and the extent to which the abundant food supplies of summer are reduced in winter is almost certainly an underlying cause of the proportion of migrant taxa in a community (Newton & Dale 1996 a,b). The prevalence of migration at high latitudes has frequently been explained in terms of extreme seasonal changes in temperature and hence in food supplies (e.g. Herrera 1978, Terborgh 1989).

Migrants are thought to exploit seasonally abundant food resources on both the breeding and non-breeding grounds (Karr 1976c, Keast 1980). During the winter months spent in the tropics, migrants are faced with a greater diversity of potential food resources than during the temperate summer months (Leister 1990) and some species switch diet seasonally in order to exploit these resources (Willis 1966, Sick 1968, Morse 1971, Karr 1976a). For example, many N-N migrants, even though morphologically specialised for capturing insects, incorporate fruits and berries in their diets during their stay in the tropics (Rappole *et al.* 1983, 1993).

Different food sources fluctuate differently with seasonal changes. The availability of fruit and flowers, for example, depends on energy surpluses of plants; these vary seasonally (Levey & Stiles 1992). It could therefore be hypothesised that birds targeting fruit and flowers would be forced to engage in seasonal movements. Considering four major food resources (fruits, seeds, nectar and arthropods) eaten by land birds (excluding birds of prey and aerial feeders) at a study site in tropical Kenya, Lack (1986a) found that fruit and seeds were available all year round whereas nectar was mostly available in the wet season. Arthropods (mainly insects) were available all year, but did show marked fluctuations in abundance, increasing in the wet season (Lack 1986 a,b, Morel 1968). It is likely that the tendency to migrate is associated with those foods that are seasonally more variable and ephemeral. Based on Lack's (1986a) analysis of Kenyan land bird species, as well as analyses of southern Afrotropical bird families (Hockey 2000), and species (Mills 2000), it is evident that migration in the Afrotropics is strongly associated with insectivory, nomadism with granivory and residency with frugivory.

Invertebrates make up most or all of the diet of a wide range of migratory species (Hockey in press). All Intra-African migrants breeding in southern Africa (Hockey 2000), and all Palearctic-Afrotropical migrants (Lack 1986a, Lövei 1989) are either partially or exclusively invertebrate feeders, with the majority being insectivorous.

In Africa, frugivores tend to be resident (Lack 1986a, Hockey 2000, Mills 2000). In the Neotropics, however, the situation is different. Levey & Stiles (1992) suggested a relationship between frugivory and nectivory and local, altitudinal and intra-tropical movements. Among Neotropical flycatchers, frugivorous species typically fly farther south than insectivorous species to reach their winter destinations, suggesting that, at least among this group, the evolution of long distance migration was most likely in highly frugivorous species (Levey & Stiles 1992). However, there are more fruit-bearing plant species in the Neotropics compared with the temperate zone (Wheelright 1988). Due to the relative lack of fruit biomass in the temperate zone, it is unlikely that heavily frugivorous lineages would develop migration to breed in this zone (Karr 1971, Willson 1986), and, indeed, long distance migrants are poorly represented among heavily frugivorous lineages of the Neotropics (Chesser & Levey 1998). Most frugivorous birds in eastern North America are only partly and/or seasonally frugivorous (Willson 1986). Relative to the Neotropics and Australia (Fullagar *et al.* 1988, Levey & Stiles 1992, Chesser & Levey 1988) as well as the Mediterranean (Lövei 1989), there are no specialised migratory frugivores in Africa (Lack 1986a, Hockey 2000). The paucity of

frugivorous species not only among migratory species, but also in the African avifauna as a whole, has been attributed to the lack of diversification of the Palmae and Lauraceae plant families, both of which contribute considerably to the diets of frugivores in the Neotropics and Asia (Snow 1980).

Very few studies have targeted the EP-O migratory bird community and no dietary analysis is yet available. However, the proportion of forest habitat available in the Orient is similar to that in the Neotropics, and is far greater than that in the Afrotropics. It is possible; therefore, that EP-O birds may show a similar pattern to that observed in the Neotropics, with many migrants being frugivorous.

Patterns of bird migration may be linked not only to food, but also to the site of prey capture and the way in which prey are captured (foraging mode). There is a range of behaviours among arthropods, from aerial forms to sessile forms (Hockey 2000). Seasonal variability in the availability of flying insects is likely to be greater than that of less mobile taxa because prey closer to the ground are more protected (buffered) from harsh environments and are thus a more stable resource (proposed by Lack 1986a). The gradient of avian foraging modes from aerial to ground gleaning or boring parallels a gradient of arthropod behaviour (Hockey 2000). Consequently, birds whose hunting modes require their invertebrate prey to be active are more likely to evolve migratory behaviour than are taxa that are not dependent on highly mobile prey (Hockey 2000). In temperate latitudes, for example, woodpeckers that rely on grubs buried in the wood or bark of trees are able to remain on the breeding grounds throughout the winter because their food supply is partially protected from temperature extremes (Askin 1983).

A link exists between foraging mode and migratory propensity. Among African insectivores, species exploiting volant insects above the canopy are most likely to be migratory (Hockey 2000), because these insects are most sensitive to seasonal environmental changes. Birds that catch insects within the canopy (perch-and-sally hunters or foliage gleaners) are more likely to be migratory than those that catch insects on the ground (perch-and-pounce hunters) (Hockey 2000). Species that eat litter-dwelling insects are most likely to be resident (Moreau 1972, Lack 1986a, 1990, Hockey 2000).

Despite the intuitive link between food and migration, surprisingly few studies have addressed the question of how food availability and prey capture mode might affect migratory behaviour (Rappole 1995, Hockey in press). A few studies (Hockey 2000, Mills 2000, Balme 2001) have considered the effects that food availability and foraging mode have on migratory behaviour at a regional level, but little is known at the global scale.

Aims and objectives

This chapter aims to quantify the diet and foraging mode of all Holarctic-breeding migrants on both the breeding and wintering grounds, and to compare patterns across the three major flyways.

The following hypotheses are tested:

- Invertebrates figure prominently in the diet of all Holarctic-breeding migrants.
- Diets of migrants vary seasonally.
- Diet selection within habitats is similar across the three flyways.
- Foraging modes within habitats are similar across the three flyways.

METHODS

Establishing the data set

Taxon lists were compiled as for Chapter 1.

The diets of all migrant taxa on the breeding and non-breeding grounds on each of the three flyways were determined from the literature (Appendix 2). Numerous dietary categories were recognised and each taxon was classified according to its primary food resource/s, except for those considered to be dietary generalists. It is important to note that in many cases migrant taxa do supplement their diet with other, less important food items that are not detailed in Appendix 2.

Dietary categories were:

V = Vertebrate feeders (including terrestrial and aquatic vertebrates)

V + I = Taxa feeding on a combination of vertebrates and invertebrates

I = Invertebrate feeders, mainly insects (including terrestrial and aquatic invertebrates)

S = Granivores

I + S = Taxa feeding on both invertebrates and seeds

F = Frugivores and nectarivores

I + F = Taxa feeding on both invertebrates and fruit or nectar

P = Plant matter (taxa eating seeds and fruit/nectar and/or other plant matter e.g. leaves and bulbs)

G = Generalists; taxa to which one of the above major dietary categories could not be allocated

For all three flyways, taxa were further categorised on the basis of foraging mode. This information was derived from the literature (Appendix 2). No distinction was made between foraging mode on the breeding and non-breeding grounds. Five foraging modes were recognised and each migrant taxon was classified according to its primary method or methods of obtaining food: many taxa regularly use more than one foraging mode. Note that in many cases migrant taxa may occasionally forage using other techniques not detailed in Appendix 2.

Foraging mode categories were:

- A = Aerial (capturing flying insects while in prolonged continuous flight), includes aerial-pursuit (chasing and catching birds in mid-air)
- S = Perch and Sally (sallies from perch on short flights to catch flying insects)
- P = Pounce (including perch-pounce, hover-pounce and the aerial search-drop/swoop technique of many raptors)
- V = Gleaning from leaves and woody vegetation (including hover-glean)
- G = Gleaning from the ground (includes digging, probing and scavenging)

Data analysis

For all dietary analyses that follow, taxa feeding on plant matter and generalist feeders were excluded. These make up only 2% of taxa on each of the breeding grounds (Nearctic, Western Palearctic & Eastern Palearctic), 2 % of taxa on the Neotropical and Afrotropical wintering grounds and 3% of taxa on the Oriental wintering grounds (Table 3.1)

Dietary preferences across flyways

Diets of migrant taxa on the breeding and non-breeding grounds were compared across the three flyways using a Chi-squared test for independent samples. Breeding season diets were further compared with diet in the non-breeding season across all three flyways using a chi-squared test for independent samples.

Diet, habitat occupancy and migration distance

Diet selection of migrant taxa on the breeding grounds within the three habitat categories, well-buffered, moderately buffered and unbuffered (Chapter 2), were compared across the three flyways using Chi-squared tests for independent samples. Habitat generalists (23 N-N taxa, 23 WP-A taxa & 33 EP-O taxa) were excluded. Diet selection of migrant taxa within each habitat category, on the non-breeding grounds, was compared across the three flyways as for the breeding range. Habitat generalists, (27 N-N taxa, 18 WP-A taxa & 32 EP-O taxa) were again excluded. In comparisons of diet in well-buffered habitat on the non-breeding grounds, only the Neotropics and the Orient were compared because only 3 taxa inhabit well-buffered habitats in the Afrotropics. Dietary preferences of migrant taxa across 5° latitude bands were compared across the three flyways. Only those 5° latitude bands where more than 10 taxa spend the non-breeding season were included.

Foraging mode comparisons

Foraging modes of migrants were compared across the three flyways using a chi-squared test for independent samples. Migrant taxa with only one foraging mode scored 1, while taxa falling in two foraging categories scored 0.5 in each, following the same criteria as Lack (1986a) and Pearson & Lack (1992). On the WP-A flyway, Common Redstart *Phoenicurus phoenicurus* was excluded as this taxon was recorded as having three main foraging techniques (S,P,V). Foraging modes of obligate insectivores (I), obligate and facultative frugivores/nectarivores or granivores (F or S) and obligate and facultative vertebrate feeders (V) were compared across the flyways using a Chi-squared test for independent samples.

Foraging modes of migrants on the non-breeding grounds within the three habitat categories were also compared across the three flyways using a Chi-squared test for independent samples. Habitat generalists (27 N-N taxa, 18 WP-A taxa and 32 EP-O taxa) were excluded. In comparisons of foraging mode within well-buffered habitats, only the N-N and EP-O flyways were compared because only three taxa inhabit well-buffered habitats in the Afrotropics. All statistical analyses were performed using STATISTICA 6 (2002) and Zar (1999).

RESULTS

Dietary preferences across flyways

There was a significant difference in breeding season diets across the three flyways ($\chi^2 = 52.55$, $p < 0.001$, $df = 8$). Diet in the Neotropics was the most diverse and differed significantly from diet in both the Western Palearctic ($\chi^2 = 30.86$, $p < 0.001$, $df = 4$) and the Eastern Palearctic ($\chi^2 = 34.90$, $p < 0.001$, $df = 4$; Fig. 3.1). There was no significant difference in diet between the Western and Eastern Palearctic (Fig. 3.1). On all flyways, the majority of taxa were primarily invertebrate (mainly insect) feeders during the breeding season: 57% of Nearctic taxa, 68% of Western Palearctic taxa and 72% of Eastern Palearctic taxa fall into this category (Fig. 3.1). In the Nearctic, considerably more taxa fed on fruit, or a combination of invertebrates and fruit, or invertebrates and seeds, relative to the Palearctic (Fig. 3.1).

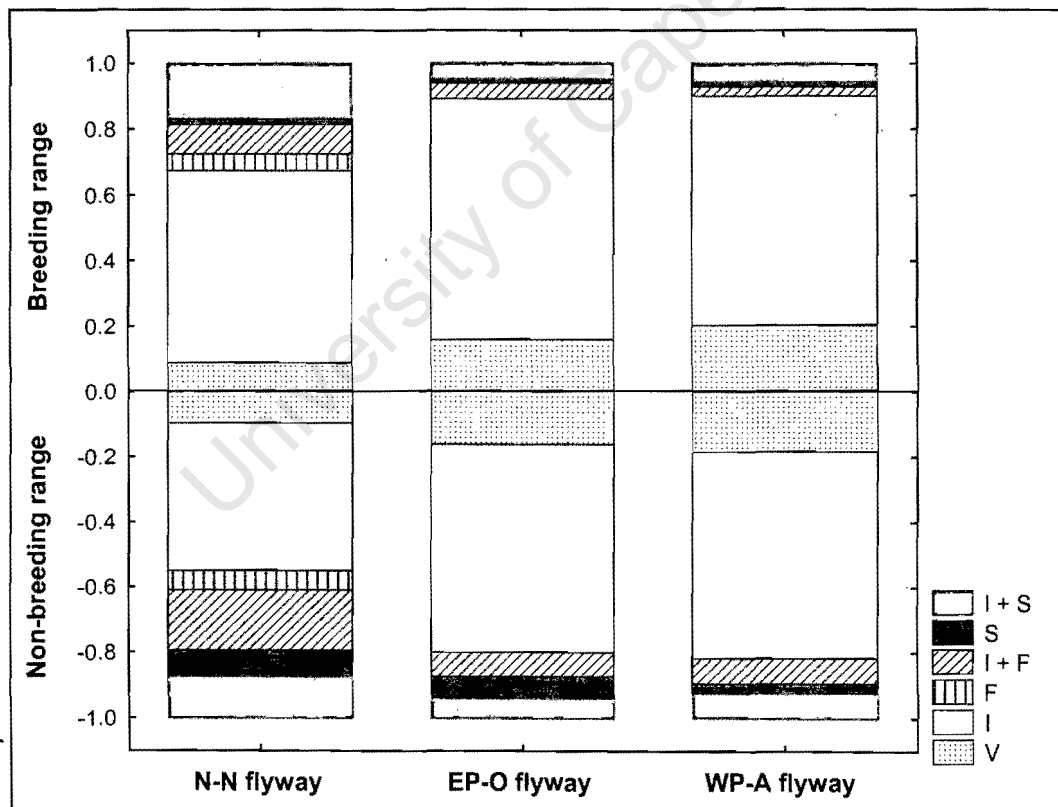


Figure 3.1: Comparison of diet (as a proportion of all migrant taxa) in the breeding and non-breeding ranges of all three flyway. Diet categories are: (V) vertebrate feeders, (I) obligate insectivores, (F) obligate frugivores/nectarivores, (I+F) facultative frugivores/nectarivores, (S) obligate granivores and (I+S) facultative granivores.

There were also significant differences in diet across flyways on the non-breeding grounds ($\chi^2 = 53.03$, $p < 0.001$, $df = 8$). As on the breeding grounds, there was a significant difference between diet on the non-breeding grounds of the N-N and both the WP-A ($\chi^2 = 32.01$, $p < 0.001$, $df = 6$) and EP-O (-Au) ($\chi^2 = 41.57$, $p < 0.001$, $df = 6$) flyways (Fig. 3.1). There was, however, no significant difference in diet on the wintering grounds between the two Old World flyways (Fig. 3.1). Invertebrates (mainly insects) were the primary food eaten by Holarctic-breeding migrants wintering in the tropics (44% of N-N taxa, 62% of both WP-A and EP-O taxa (Fig. 3.1). A considerably higher proportion of taxa fed on seeds or fruits/nectar in the Neotropics than in the Afrotropics or the Orient (Fig. 3.1).

On the N-N flyway there was a significant difference ($\chi^2 = 23.06$, $p < 0.002$, $df = 4$) between diet on the breeding and non-breeding grounds (Fig. 3.1). On the non-breeding grounds there was a decrease in the proportion of taxa feeding primarily on invertebrates and also in those feeding on a combination of invertebrates and seeds. By contrast, granivory and frugivory/nectarivory both increased on the non-breeding grounds. On both the WP-A and EP-O flyways diets on the breeding and non-breeding grounds did not differ (Fig. 3.1).

Diet, habitat occupancy and migration distance

On the breeding grounds, there was a significant difference in diet selection between moderately buffered habitats across the three flyways ($\chi^2 = 48.01$, $p < 0.001$, $df = 6$; Fig. 3.2). The Nearctic had a greater proportion of frugivores/nectarivores and granivores and fewer insectivores and vertebrate feeders compared to the Old World breeding grounds. There were however, no significant differences in diet selection within well-buffered and unbuffered habitats across the three flyways.

On the non-breeding grounds there was a significant difference in diet selection between well-buffered habitats of the N-N and EP-O flyways ($\chi^2 = 18.78$, $p < 0.001$, $df = 3$; Fig. 3.3). The N-N flyway supports a greater proportion of obligate and facultative frugivores/nectarivores and fewer insectivores than the EP-O flyway. There was also a significant difference in diet within the moderately buffered habitats of all three flyways ($\chi^2 = 33.73$, $p < 0.001$, $df = 6$; Fig. 3.3). This difference occurs as a result of the considerable difference in the proportion of granivores and insectivores. The Neotropics has a prevalence of granivores and relatively few insectivores, while the Afrotropics

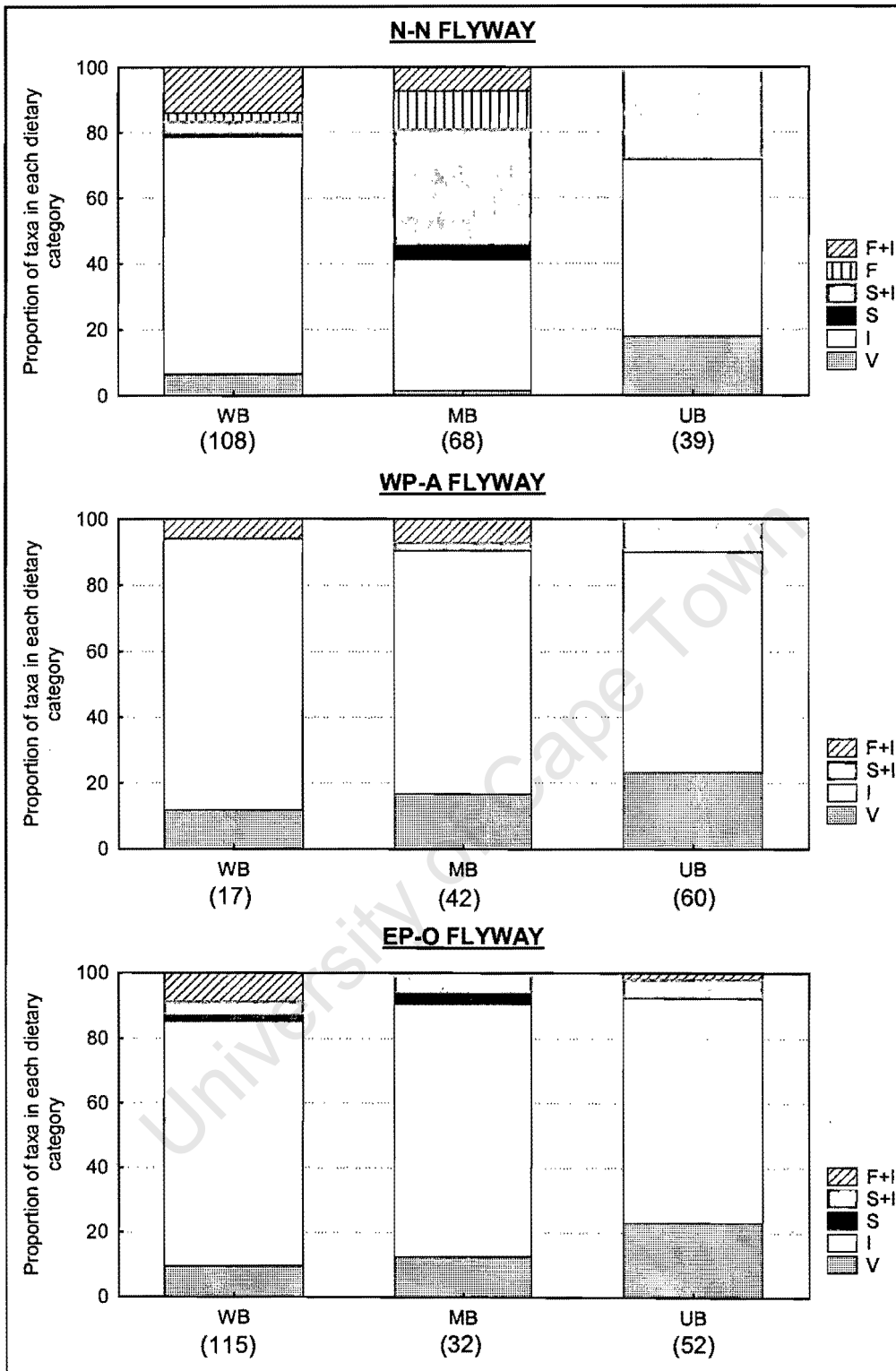


Figure 3.2: Comparison of diet selection within each habitat category (well-buffered (WB), moderately buffered (MB) and unbuffered (UB)) on the breeding grounds of all three flyways. Figures in brackets indicate number of taxa. Refer to Fig. 3.1 for key to diet codes.

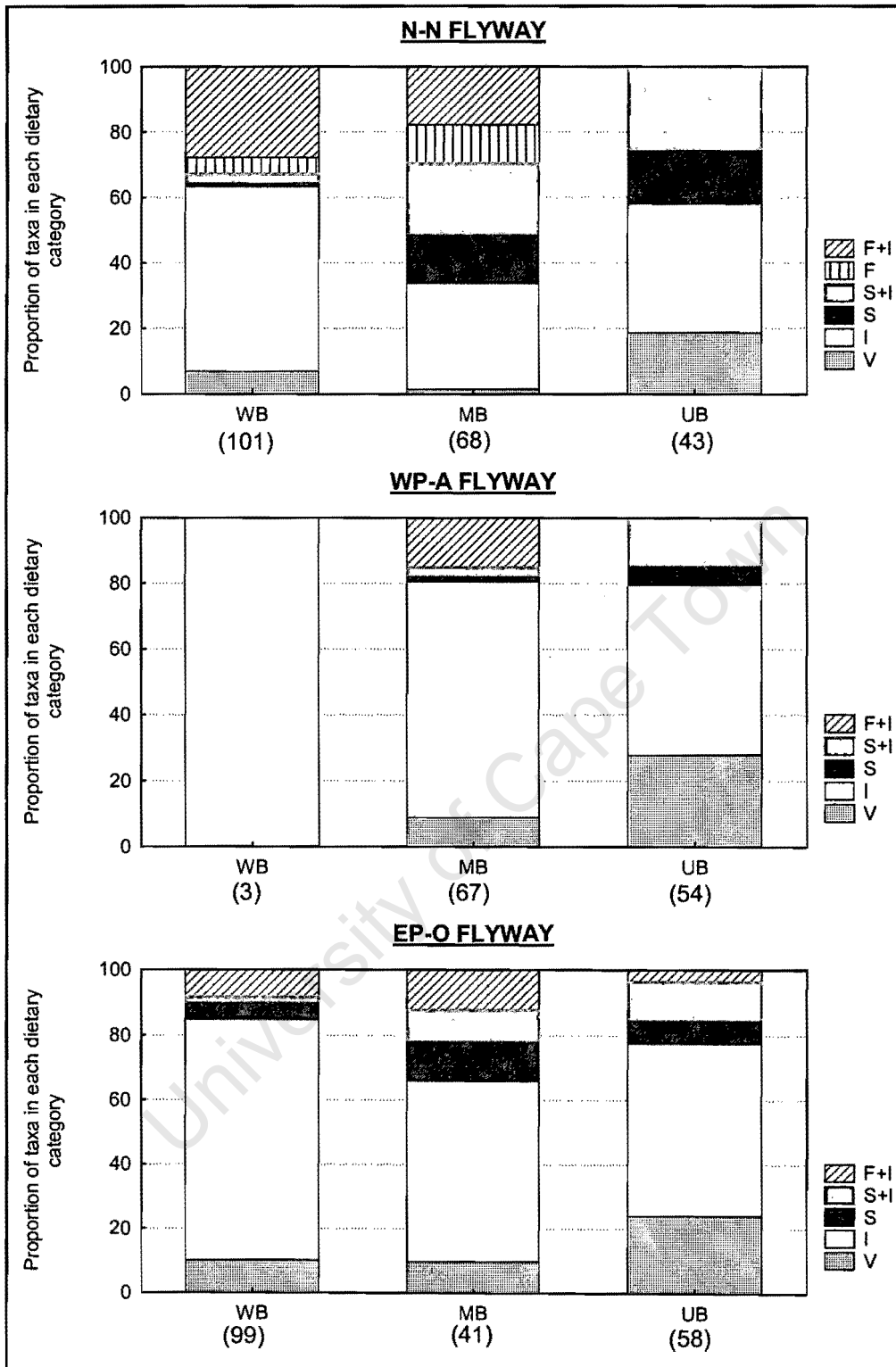


Figure 3.3: Comparison of diet selection within each habitat category (well-buffered (WB), moderately buffered (MB) and unbuffered (UB)) on the non-breeding grounds of all three flyways. Figures in brackets indicate number of taxa. Refer to Fig. 3.1 for key to diet codes.

support few granivores and a considerable proportion of insectivores. The Orient is intermediate between the two. There was no significant difference in diet selection within unbuffered habitats across the three flyways (Fig. 3.3).

The frequency of predation on vertebrates on both the breeding and non-breeding grounds generally increased with decreasing buffering across all three flyways (Figs 3.2, 3.3). Granivores were characteristic of less buffered habitats on both the breeding and non-breeding grounds of all three flyways (Figs 3.2, 3.3). Other cross-habitat trends in diet on the breeding and non-breeding grounds are less consistent. Obligate insectivory was generally less prevalent in open habitats than in well-buffered habitats, and insectivory was more pronounced in all habitats on the Old World flyways than in equivalent habitats in the New World (Figs 3.2, 3.3). Frugivores avoided open habitats on all flyways (Figs 3.2, 3.3).

Three latitudinal patterns related to diet are repeated across all three flyways. Insectivory becomes increasingly prevalent with increased distance from the breeding grounds (Fig. 3.4). The reverse trend is shown by facultative or obligate granivores and to a lesser degree by facultative and obligate frugivores/nectarivores, particularly in the Northern Hemisphere (Fig. 3.4).

Foraging mode comparisons

There were significant differences in foraging modes between the three flyways ($\chi^2 = 44.67$, $p < 0.001$, $df = 8$). Significant differences in foraging modes exist between all flyways (N-N and WP-A, $\chi^2 = 40.44$, $p < 0.001$; N-N and EP-O, $\chi^2 = 15.75$, $p < 0.005$; WP-A and EP-O, $\chi^2 = 15.17$, $p < 0.005$; all $df = 4$; Fig. 3.5). The most striking features of this comparison are the prevalence of vegetation gleaners in the Neotropics and of perch-and-pounce and aerial hunters in the Afrotropics. Overall, foraging behaviour on the EP-O flyway is intermediate between the N-N and WP-A flyways (Fig. 3.5).

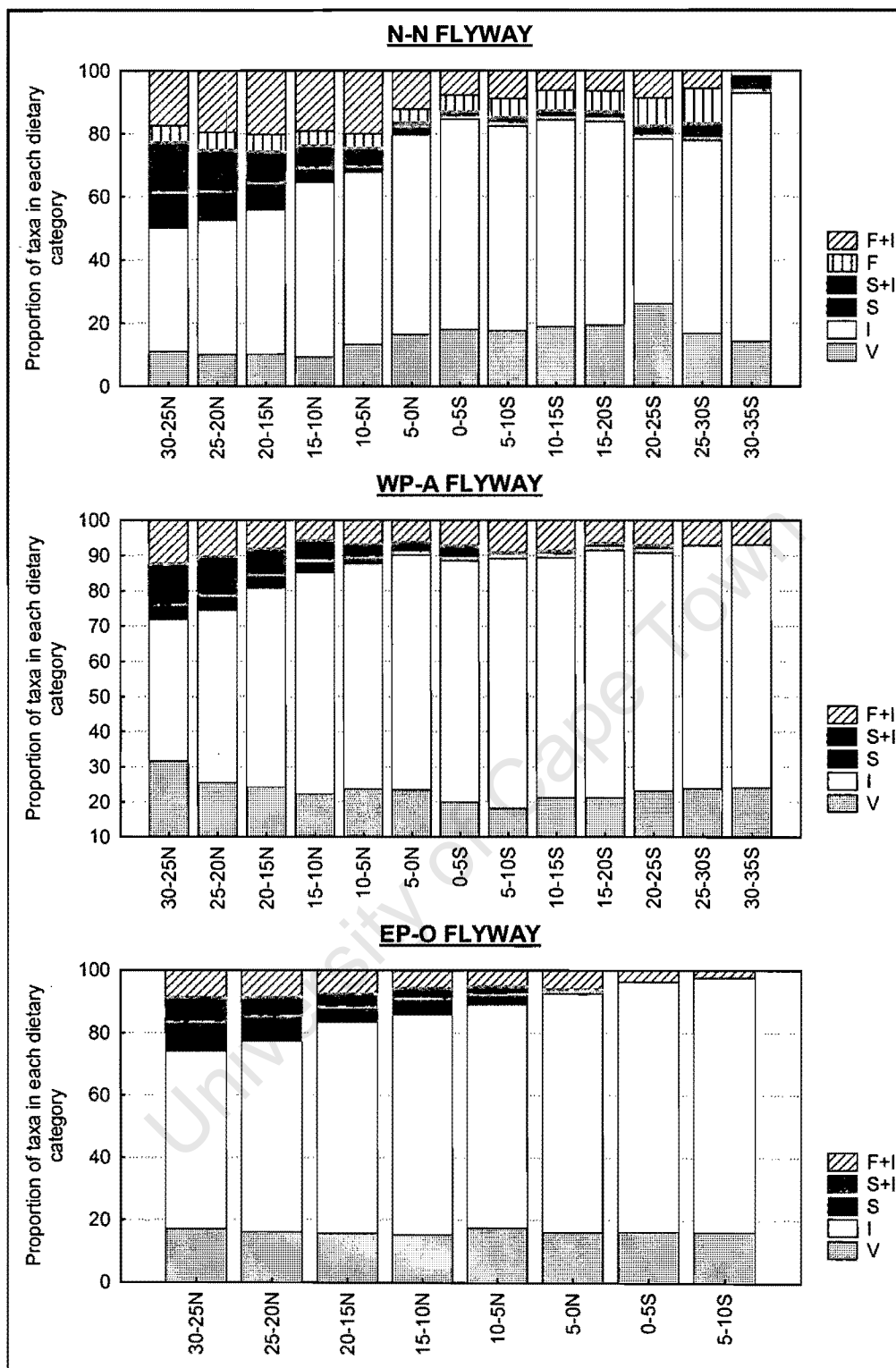


Figure 3.4: Latitudinal variation in diet on the non-breeding grounds across flyways. Refer to Fig. 3.1 for key to diet codes.

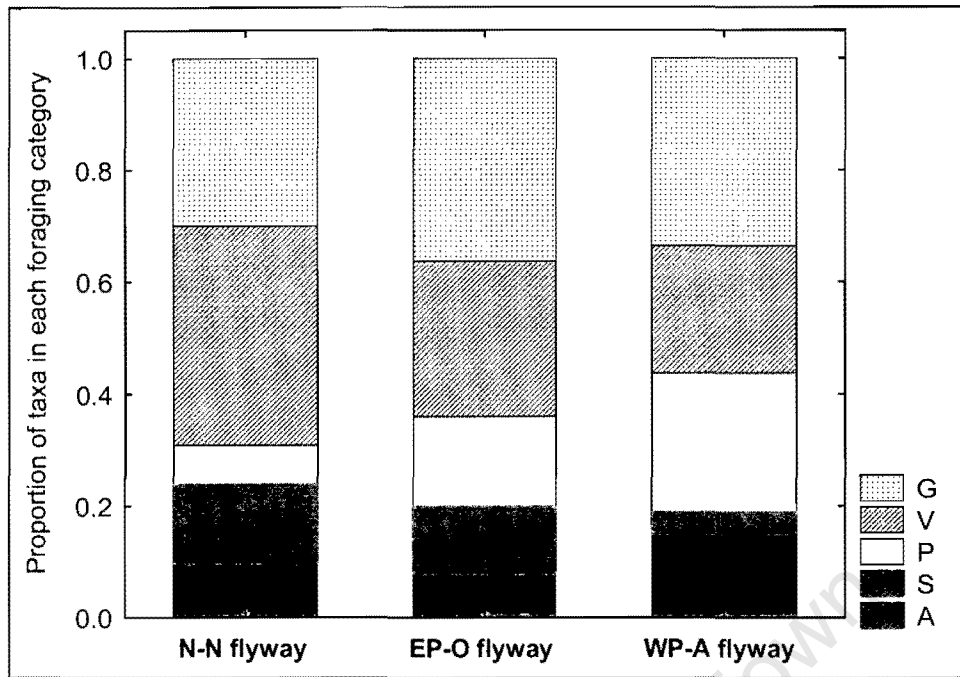


Figure 3.5: Comparison of foraging modes (as a proportion of all migrant taxa) across the three flyways. Foraging mode categories are: (A) aerial, (S) perch-and-sally, (P) pounce, (V) vegetation glean and (G) ground glean.

On all three flyways, most obligate insectivores gleaned their prey from the ground or vegetation but many also used aerial foraging, perch-and-sally and pounce techniques (Fig. 3.6). There was however a significant difference ($\chi^2 = 48.57$, $p < 0.001$, $df = 8$) in the foraging mode of obligate insectivores (taxa feeding mainly on invertebrates in the breeding and non-breeding season) across the three flyways (Fig. 3.6). There was a prevalence of vegetation gleaners and perch-and-sally hunters on the N-N flyway. The WP-A flyway on the other hand had a greater proportion of insectivores that glean from the ground and perch-and-pounce. The foraging behaviour of obligate insectivores on the EP-O flyway was intermediate between the N-N and WP-A flyways. There was no significant difference in the foraging technique used by frugivores/nectarivores or granivores, with the majority of taxa obtaining their prey by gleaning from the ground or vegetation (Fig. 3.6). There was also no significant difference in the foraging mode used by vertebrate (obligate or facultative) hunters across the three flyways (Fig. 3.6). Vertebrate hunters capture their prey primarily by aerial pursuit or by pouncing upon it.

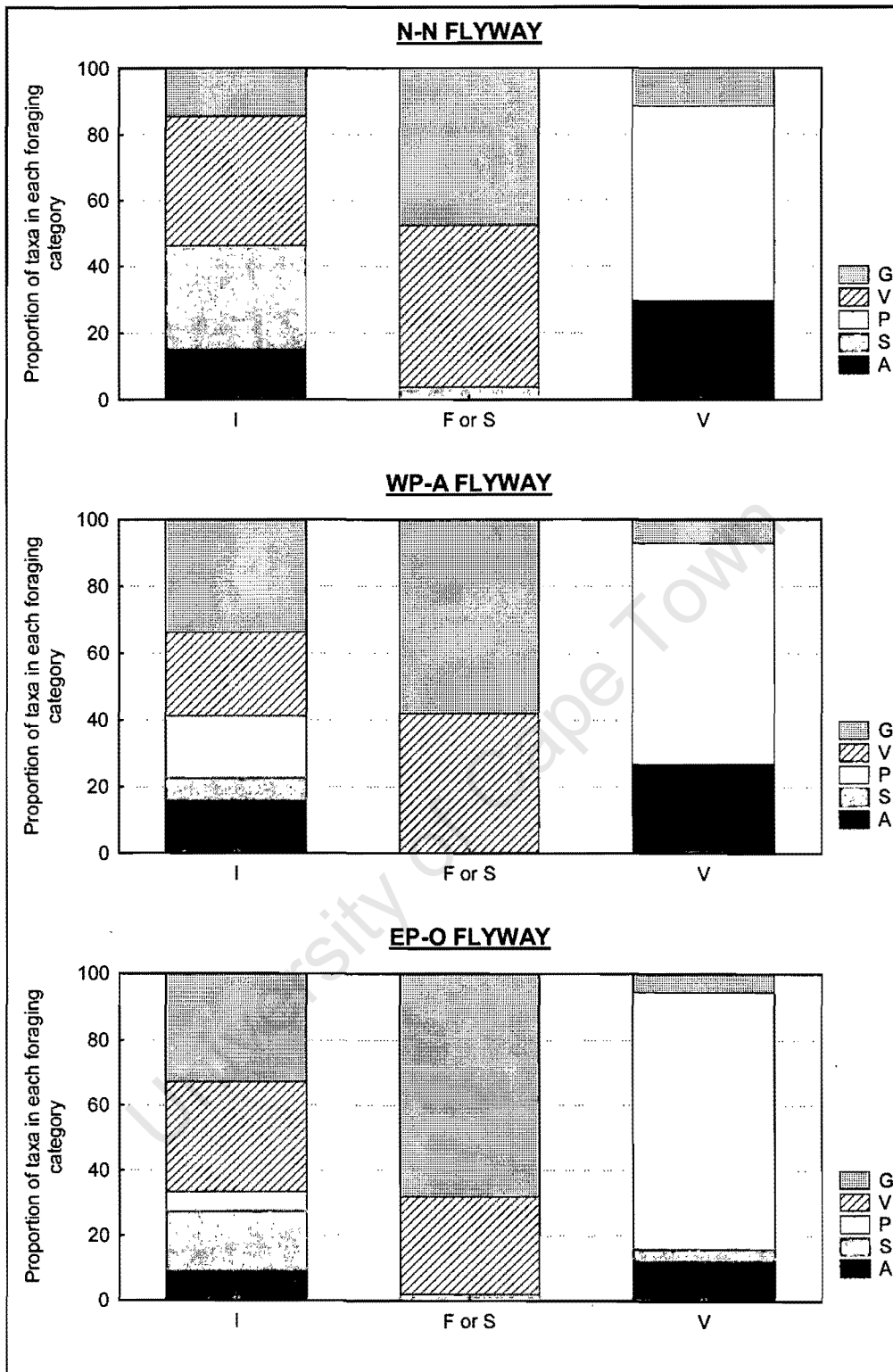


Figure 3.6: The proportion of obligate insectivores (I), frugivores/nectarivores or granivores (F or S) and vertebrate feeders (V) using different foraging techniques across the three flyways. Foraging mode codes are summarised in Fig. 3.5.

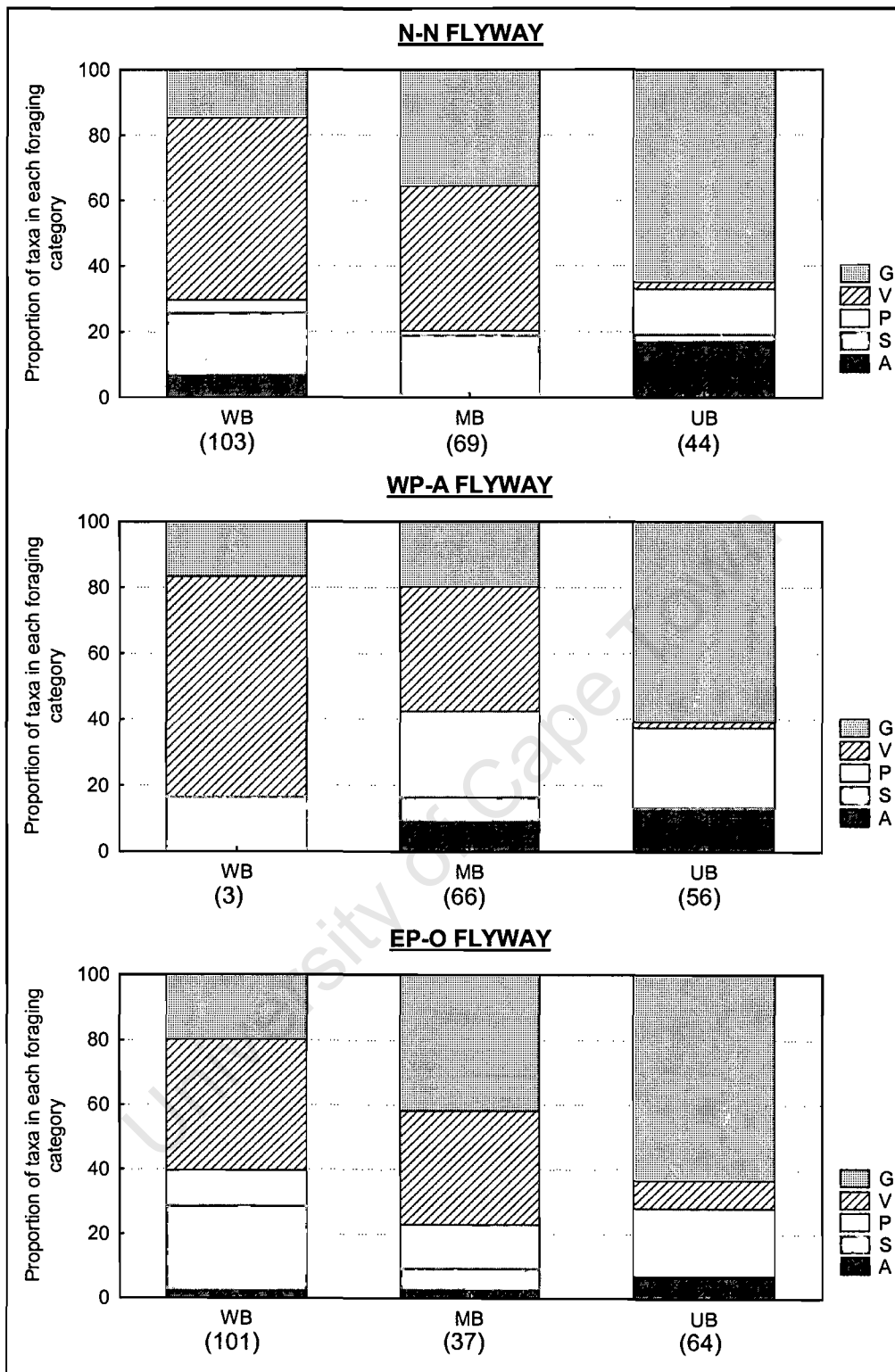


Figure 3.7: Comparison of migrant foraging mode within each habitat category (well-buffered (WB), moderately buffered (MB) and unbuffered (UB)) across the three flyways. Figures in brackets indicate number of taxa. Foraging mode codes are summarised in Fig. 3.5.

On all three flyways, there was no significant difference in foraging mode within well-buffered or unbuffered habitats (Fig. 3.7). There was, however a significant difference in foraging mode within moderately buffered habitats across the flyways ($\chi^2 = 31.97$, $p < 0.001$, $df = 8$; Fig. 3.7). The greatest difference occurs between the proportion of perch-and-pounce hunters that occupy moderately buffered habitats.

Moving from well-buffered (closed) to unbuffered (open) habitats within flyways, some general trends are evident (Fig. 3.7). The proportion of vegetation gleaners decreases and there is an increase in the proportion of ground-gleaners. Similarly, as habitat becomes increasingly open the importance of perch-and-sallying as a hunting technique decreases, and of perch-and-pouncing increases. There is a slight tendency for the proportion of aerial hunters to increase with decreased buffering.

DISCUSSION

Dietary preferences across flyways

Across all flyways, the majority of taxa are at least partially insectivorous during the breeding season (N-N 206, WP-A 125, EP-O 212). A large proportion of these insectivores (67-80%) are obligate or near-obligate insectivores at this time (Table 3.1). The diet spectrum in the Western and Eastern Palearctic is similar, but differs from the Nearctic (Fig. 3.1). There are considerably more granivorous and frugivorous/nectarivorous migrants in the Nearctic and correspondingly fewer obligate insectivores (Fig. 3.1).

The prevalence of insectivory (obligate or facultative) persists on the non-breeding grounds (N-N 189, WP-A 127, and EP-O 199 taxa). Of these insectivores, 57-74 % are obligate or near-obligate insectivores (Table 3.1). The diet of migrants wintering in the Neotropics differs considerably from that of their Old World counterparts (Fig. 3.1). A large proportion of Old World taxa are obligate insectivores, whereas many of the New World insectivores also include fruit, seeds or nectar in their non-breeding diet (Fig. 3.1). Overall, the dependency of New World taxa on insects is reduced in the non-breeding season (Fig. 3.1).

Table 3.1: The number of migrant taxa in each dietary category on the breeding (BR) and non-breeding (NBR) grounds across flyways.

Diet	N-N flyway		WP-A flyway		EP-O flyway	
	BR	NBR	BR	NBR	BR	NBR
Monophagous species						
vertebrates	15	16	15	11	17	16
invertebrates (mainly insects)	139	108	99	90	170	147
seeds	4	19	2	4	3	15
fruit/nectar	12	14	0	0	0	0
Polyphagous species						
vertebrates + invertebrates	6	7	14	15	20	21
seeds + invertebrates	40	30	8	11	11	14
fruit/nectar + invertebrates	21	44	4	11	11	17
plant matter (fruit & seeds or other plant material)	3	3	0	0	1	2
generalist (invertebrates and plant matter)	3	2	3	3	4	5
Total (excl. taxa where diet unknown)	243	243	145	145	237	237
all vertebrate feeders	21	23	29	26	37	37
all invertebrate feeders (excl. p and o)	206	189	125	127	212	199
all seed feeders (excl. p and o)	44	49	10	15	14	29
all fruit/nectar feeders (excl. p and o)	33	58	4	11	11	17

The relatively high proportion of frugivorous or partially frugivorous N-N migrants has been attributed to the diversity of Palmae and Lauraceae plant families in the Neotropics (Snow 1980). However, there is also a diverse array of Palmae and Lauraceae in Asia (Snow 1980) and, if this alone was a sufficient explanation for the high incidence of frugivory, it could be predicted that there would be many frugivores or partial frugivores on the Oriental wintering grounds. However, this is not the case: there are no obligatory frugivorous migrants in this region and only 7% (17 taxa) of all EP-O migrants are partially frugivorous on their wintering grounds (Table 3.1). Indeed, the proportion of partially frugivorous migrant taxa on the wintering grounds of the EP-O flyway is very similar to the proportion on the wintering grounds of the WP-A flyway (8% - 11 taxa; Table 3.1). The WP-A flyway also has no exclusively frugivorous migrants (Table 3.1).

The diet spectrum of migrants in the Afrotropics and the Orient is similar (Fig. 3.1). There is a slightly greater proportion of granivores in the Orient (6%) than the Afrotropics (3%), but this difference is not significant (Table 3.1).

Overall, dietary diversity is greater on the wintering grounds than on the breeding grounds (Fig. 3.1, Appendix 2). This might be because a) migrants spending the winter months in the tropics are faced with more diverse food resources than during the boreal

summer months (Leister 1990), and/or b) that the energy, protein and calcium demands of reproduction constrain dietary opportunism in summer (Ward 1969, Fogden 1972, Jones & Ward 1976, Ricklefs 1976, Fogden & Fogden 1979).

The diet of N-N taxa on the breeding grounds differs considerably from that on the non-breeding range (Fig. 3.1). Nineteen percent (46 taxa) of N-N migrant taxa switch diet between the breeding and non-breeding seasons. On the breeding grounds 139 taxa are obligate insectivores; only 108 taxa remain so in winter (Table 3.1). Many migrants (22 taxa) that feed on invertebrates on the breeding grounds supplement their invertebrate diet with fruit on the non-breeding grounds (Appendix 2). This concurs with the findings of Martin *et al.* (1951) and Wheelwright (1988) who also found that many American birds switch from eating insects in summer to eating fruits in winter. Of the 18 taxa (excluding generalists) that are obligate granivores on the Neotropical wintering grounds, 12 supplement their diet on their breeding grounds with protein-rich invertebrates and 2 become obligate insectivores (Appendix 2).

On the WP-A and EP-O flyways, 13% of migrant taxa (19 WP-A taxa, 30 EP-O taxa) switch their diet between the breeding and non-breeding seasons. On both these flyways there is a small increase in the number of migrant taxa feeding on seeds or fruit during the non-breeding season (Fig. 3.1). Some taxa that feed on invertebrates during the breeding season take a combination of invertebrates and seeds or invertebrates and fruit in winter (11 WP-A taxa, 14 EP-O taxa) (Appendix 2). On the EP-O flyway, seven taxa that feed primarily on invertebrates during the breeding season take seeds on their wintering grounds. However, these dietary changes had no significant effect on the overall dietary spectrum, which remained the same in summer and winter (Fig. 3.1).

Although some migrants supplement their winter diets with seeds, there is little evidence for migration by granivores in the southern and eastern Afrotropics (Lack 1986a, Dean 1997, Hockey 2000) or, indeed, among Palearctic-Afrotropical migrants in general (Moreau 1972). Analyses presented here (Fig. 3.1) show that on all three flyways (particularly the WP-A flyway) there are only small proportions of granivorous Holarctic-breeding migrants. Analogous to the findings of Chesser and Levey (1998), there is a poor representation of obligatory frugivorous Holarctic-breeding migrants (Fig. 3.1). Most Holarctic-breeding frugivorous migrant taxa (all in the case of the WP-A and EP-O flyways) are only partially frugivorous (as shown by Willson 1986) (Table 3.1).

Diet, habitat occupancy and migration distance

Diet selection within moderately buffered habitats on the breeding grounds differs across the three flyways, with a much larger proportion of granivores and frugivores/nectarivores and fewer insectivores and vertebrate feeders in the Nearctic than elsewhere (Fig. 3.2). There is no variation in diet in either well-buffered or unbuffered habitats on the breeding grounds across the three flyways.

On the non-breeding grounds, diet selection within both well-buffered and moderately buffered habitats differs across the three flyways (Fig. 3.3). These inter-flyway differences are a result of the difference in the proportion of frugivores/nectarivores (facultative and obligate) in well-buffered habitats and differences in the proportion of granivores (facultative and obligate) in moderately buffered habitats respectively. In moderately buffered habitats of the Neotropics, there is a greater proportion of granivores and relatively few insectivores compared to the Afrotropics, which has a prevalence of insectivores and very few granivores. The Orient is intermediate between the two. Diet selection of taxa occupying unbuffered habitats on the non-breeding grounds is similar across the three flyways (Fig. 3.3).

Whilst the proportional representation of different food types in the diets of migrants varies between seasonal ranges and flyways (at least between the Old and New Worlds), some trends linking diet and habitat occupancy are repeated both across breeding and non-breeding ranges and across flyways (Figs 3.2, 3.3). Most obvious among these is that the incidence of obligate insectivory is positively related to habitat buffering (particularly on the non-breeding grounds). Insectivory is also more pronounced in both the breeding and non-breeding ranges on the Old World flyways than in equivalent habitats in the New World (Figs 3.2, 3.3). Granivory is characteristic of more open habitats (as reported by Lövei 1989) as are vertebrate hunting. Frugivores, by contrast (and not surprisingly), avoid open habitats (consistent with observations of Lövei 1989).

Diets on the N-N flyway differ between the breeding and non-breeding grounds. Although there are examples of taxa that switch diet between the breeding and non-breeding ranges of the WP-A and EP-O flyways, these have no significant effect on the overall dietary spectrum. However, when considering diet within habitats and between breeding and non-breeding ranges, some trends are repeated across flyways (Figs 3.2, 3.3). The most striking difference is the increase in frugivory in moderately and well-buffered habitats in the Neotropics during the non-breeding season and the increase in frugivory in moderately buffered habitats in the Orient. On all three flyways, obligate insectivores are

generally less prevalent in most habitats on the non-breeding grounds than on the breeding grounds. Within more open habitats, there is also a tendency for the number of granivores, particularly obligate granivores, to increase on the non-breeding grounds. There is very little variation in the proportion of vertebrate hunters within habitat categories across seasonal ranges. Given that these tend to be large, specialised predators; the lack of seasonal diet change is not surprising.

There are also repeated trends in diet linked to migration distance (Fig. 3.4). Obligate and facultative granivores, for example, are concentrated in the northern tropics (as noted by Moreau (1972) and Pearson & Lack (1992)). The prevalence of frugivores also decreases from north to south. The proportion of insectivores, on the other hand, increases with increasing migration distance at least to as far south as the Equator. In other words, insectivores are disproportionately well represented in the Southern Hemisphere. This could be interpreted as being indicative of the persistence time of the different food types following the onset of the northern winter. Seeds that have not germinated by the end of the summer rains in the northern tropics have a long persistence time, whereas insects, at the other end of the spectrum, respond rapidly to decreasing temperatures. Insectivores whose southward migrations cross the Equator benefit from the flush of insects during the austral summer (Moreau 1972). North of the equator rain falls mainly towards the end of the northern summer, so migrants are present after the rain (Newton 1995). In contrast, south of the equator, migrants are present during the wet season (Newton 1995). This too explains the paucity of granivores south of the equator. Seed eaters would have poor prospects wintering in the southern tropics, when as a result of germination, seeds disappear with the onset of rain (Newton 1995).

Foraging mode comparisons

Foraging mode is closely, but not necessarily predictably, linked to diet. The prevalence of different foraging modes varies across flyways, forming a continuum with the Neotropics and Afrotropics at the extremes (Fig. 3.5). The Neotropics are characterised by vegetation gleaners (a mix of insectivores, frugivores and nectarivores) and perch-and-sally foragers, while the Afrotropics has the highest representation of perch-and-pounce and aerial hunters. The large tracts of closed forests in the Neotropics and open savanna-like habitats in Africa may be sufficient to explain this dichotomy. What it does not convincingly explain is the intermediate spectrum of foraging modes in the Orient (which is also extensively forested). However, migrants in the Orient show

significant avoidance of well-buffered habitats (Chapter 2), itself partly due to the open-habitat preferences of taxa that migrate both to the Orient and to Africa.

On all three flyways, a large proportion of year-round, obligate insectivores glean their prey from the ground or from vegetation (Fig. 3.6). However, on all three flyways, many also obtain their food by aerial foraging, perch-and-sally and pouncing techniques (Fig. 3.6). Similarly, among land birds in Kenya, aerial hunters, pouncers and twig-gleaners are almost exclusively insectivorous (Lack 1986a). The proportion of invertebrate-feeding migrants in each of these three foraging mode categories (aerial foraging, perch-and-sally and perch-and-pounce) varies across flyways. The N-N and EP-O flyways have a greater proportion of taxa that perch-and-sally compared to the WP-A flyway. Both the N-N and EP-O flyways are largely covered by well-buffered habitats, a suitable habitat for the perch-and-sally foraging technique. By contrast, and corresponding to a greater proportion of poorly buffered habitats, the WP-A flyway has a greater proportion of taxa that pounce upon their prey.

The foraging modes of facultative and obligate granivores or frugivores/nectarivores are similar across all three flyways (Fig. 3.6). Both facultative and obligate granivores or frugivores/nectarivores obtain their prey almost entirely by gleaning from the ground or vegetation, as was shown by Lack (1986a).

Similarly, there is little difference in foraging modes of vertebrate hunters across the three flyways (Fig. 3.6). On all three flyways, the majority (58-78%) of exclusively vertebrate feeders obtain their prey by pouncing upon it. Aerial pursuit is also a common means of obtaining prey amongst vertebrate feeders. Most vertebrate feeding taxa that also eat invertebrates obtain their invertebrate prey by the same techniques used to obtain vertebrate prey, by pouncing, aerial pursuit and to a much lesser degree by ground foraging.

Given the lack of a convincing paradigm linking geography and diet, it is not surprising that no obvious paradigm links geography and foraging mode. However, just as similarities exist between diet and habitat across flyways, so they also exist between foraging mode and habitat (Fig. 3.7). Overall, as habitat buffering decreases, so too does the diversity of foraging modes employed, implying that as habitats become structurally simpler, opportunities for diversification in hunting mode are reduced. The proportional representation of vegetation-gleaners and perch-and-sally hunters decreases along a gradient of decreasing buffering. Along the same gradient, proportions of ground-gleaners and perch-and-pounce hunters increase.

Overview: Regional patterns or global paradigms?

If location (flyway) is the denominator used in the search for paradigms about diet and foraging mode of migrants, few such paradigms exist (Table 3.2). The anticipated convergence between the Orient and the Neotropics (both having extensive, well-buffered habitats) is not evident in either diet or foraging mode. Indeed, in most analyses the Orient groups more closely with Africa, the Neotropics being the outlier (Figs 3.1, 3.5, Table 3.2). Some patterns of dietary change between the breeding and non-breeding season are repeated globally (Fig. 3.1, Table 3.2). The number of frugivores (facultative only on both the WP-A and EP-O flyways) and granivores increase on the wintering grounds, while obligate insectivory decrease. These trends are most striking on the N-N flyway. These global trends are the likely result of nutritional demands of reproduction constraining diet during the breeding season (Ward 1969, Fogden 1972, Jones & Ward 1976, Ricklefs 1976, Fogden & Fogden 1979) rather than a greater diversity of food on the wintering grounds (Leister 1990).

A more convincing pattern repeated across flyways (i.e. independent of habitat) relates to the proportional representation of insectivores, frugivores/nectarivores and granivores as a function of migration distance (Table 3.2). The prevalence of insectivores increases with increasing migration distance, at least as far south as the Equator, while frugivores/nectarivores decrease from north to south. Granivores are concentrated in the northern tropics.

Despite the differences across flyways in the functional structure of their migrant bird assemblages, there are some very clear trends linking diet and foraging mode with habitat (summarised in Table 3.2). The most obvious is that the incidence of obligate insectivory is positively related to habitat buffering, while granivory and vertebrate hunting are characteristic of less buffered habitats. Frugivores/nectarivores by contrast avoid unbuffered habitats. Considering foraging modes, the proportion of vegetation gleaners and perch-and-sally hunters decreases with decreasing habitat buffering. By contrast, along the same gradient the proportion of ground gleaners and perch-and-pounce hunters increases.

In summary, therefore, information about site (distance from the breeding grounds) and habitat buffering allows some predictions to be made about diet and foraging modes of migrants on any flyway. These trends are evident independently of geography and habitat availability. However, whilst the trends have some predictive capacity, they have

little predictive precision and could not realistically be elevated above the status of “minor paradigms”.

Table 3.2: Summary of key interactions between diet, foraging mode, location and habitat. Shaded blocks indicate “paradigms” that hold true across all flyways, unshaded blocks represent regional specifics.

		Location	Habitat
Diet	Diet within breeding and non-breeding grounds	<ol style="list-style-type: none"> 1. Less obligate insectivory and more granivory and frugivory on breeding and wintering grounds on N-N flyway than on the WP-A and EP-O flyways. Importance of insectivory least in Neotropics 	<ol style="list-style-type: none"> 1. Obligate insectivory most pronounced in well-buffered habitats. 2. Granivory and predation on vertebrates most prevalent in poorly buffered habitats. 3. Frugivores avoid unbuffered habitats
	Dietary changes from breeding to non-breeding grounds	<ol style="list-style-type: none"> 1. Frugivory (facultative only on WP-A & EP-O flyways) increases. 2. Obligate granivory increases . 3. Obligate insectivory decreases. <p>Trends most striking on N-N flyway</p>	<ol style="list-style-type: none"> 1. Frugivory (only facultative on WP-A & EP-O flyways) increases within more buffered habitats . 2. Obligate granivory increases within poorly buffered habitats . 3. Obligate insectivory decreases within all habitats.
	Migratory distance	Prevalence of insectivores increases with increasing migration distance; trend reversed for frugivores and granivores.	—
Foraging mode	Marked prevalence of vegetation-gleaners in New World and of perch-and-pounce and aerial hunters in the Afrotropics; Orient intermediate.	Moving from well-buffered to open habitats, proportions of vegetation-gleaners and perch-and-sally hunters decrease; proportions of ground-gleaners and perch-and-pounce hunters increase.	

Synthesis

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SYNTHESIS

Before summarising the main conclusions of this study, two limitations need to be highlighted. Firstly, data quality varies across flyways. When compiling the database of avian attributes, confidence in all data entries was rated as good, fair or poor. Considerably more data for the EP-O flyway were rated as ‘poor’ relative to the other two flyways. Secondly, it was considered beyond the scope of this study to attempt to factor out for phylogeny. As a result, analyses are biased to some extent by taxon-rich families (Appendix 1). However, in the search for global paradigms, failure to control for phylogeny is likely to mask, rather than exaggerate, repeated patterns. For this reason, patterns that are identified as global paradigms are believed to be robust.

Similarities across the three flyways

- On all 3 flyways, TR decreases with increasing distance from the breeding grounds. However, the rate of taxon attenuation varies between flyways in response to the availability of continuous land area and the presence/absence and nature of barriers. This variability limits the predictive precision of distance alone in determining the distribution of migrants across flyways.
- Small birds are disproportionately concentrated in the tropics. Although this pattern is repeated across flyways, alone it has limited potential for predicting species’ distributions because, birds of all body weights are found at all latitudes.
- Most migrants are at least partially insectivorous during both seasons on all 3 flyways. Overall, dietary diversity is greater during winter than on the breeding grounds on all three flyways. Many migrants that feed on invertebrates on the breeding grounds supplement their diets on the non-breeding grounds with fruit/nectar or seeds; this pattern, although general, is most pronounced on the N-N flyway.
- Information about distance from the breeding grounds allows some predictions to be made about the diet of migrants on any flyway. The prevalence of insectivores increases with increasing migration distance, (at least as far south as the Equator), while the trend is reversed for granivores and frugivores.

- While the proportional representation of different food types in the diets of migrants varies between seasons and flyways, information about habitat buffering allows some predictions to be made about the diet of migrants on any flyway. Obligate insectivores are best represented in well-buffered habitats; granivores and vertebrate feeders are most prevalent in poorly buffered habitats; and frugivores avoid unbuffered habitats. These trends are evident independently of geography and habitat availability
- Trends in dietary changes within habitats between the breeding and non-breeding ranges are repeated across flyways. On all three flyways, obligate insectivores are generally less prevalent in most habitats on the non-breeding grounds. Granivory, particularly obligate, increases within poorly buffered habitats during the winter, while frugivory increases within well-buffered habitats on the non-breeding grounds.
- Although the prevalence of different foraging modes varies across the three flyways, trends exist linking foraging mode and habitat across flyways. As habitat buffering decreases, the proportion of vegetation gleaners and perch-and-sally hunters also decreases while the proportion of ground gleaners and pounce hunters increases.

Differences across the three flyways

- There are substantial differences in the geography of the N-N, WP-A, and EP-O flyways, both in terms of land area and the presence and nature of barriers that may affect migration. This strongly influences Holarctic-breeding migrant distribution on the non-breeding grounds.
- The rate of taxon attenuation is most gradual on the WP-A flyway where there are no significant land constrictions or ocean crossings between the breeding and wintering grounds. A much greater proportion of taxa migrate further south in the Afrotropics compared to the Neotropics and the Orient.
- On the WP-A flyway there is a relationship between TR and land area. However, land area is auto-correlated with distance from the breeding grounds. On the N-N and EP-O flyways, where there is no relationship between land area and migration distance, there is also no relationship between TR and land area.
- The land constrictions and ocean crossings on both the N-N and EP-O flyways strongly influence the non-breeding distributions of some Holarctic- breeding migrant taxa. The cumulative influence of ocean crossings appears to have a stronger effect on

the distribution of migrants in the Orient than in the Neotropics. On the N-N flyway the option exists for migrants to avoid the Caribbean and travel south through the Central American mainland. However, in the Orient the water crossings to the Indonesian islands cannot be avoided and birds must either fly non-stop over the ocean or avoid crossing completely.

- Leapfrog migration occurs on both the N-N and WP-A flyways. It is most pronounced on the WP-A flyway, where there are no major geographical barriers to migration and no land constrictions on the non-breeding grounds. There is no such relationship between breeding and non-breeding ranges on the EP-O flyway, suggesting that barriers may prevent migrants from optimising their migratory end-points.
- Migrant taxa present on both the WP-A and EP-O flyways penetrate further south in the Afrotropics than in the Orient, providing further support for the hypothesis that the constricting Thai-Malay peninsula and/or ocean crossings of Indonesia prevent taxa from optimising their migratory end-points.
- Habitat availability on both the breeding and non-breeding grounds differs substantially across the three major flyways. Similarly, habitat occupancy on both the breeding and non-breeding grounds differs across the three flyways. On the N-N and EP-O flyways, a large proportion of migrants occupy well-buffered habitats, in contrast to most WP-A migrants that favour moderately buffered or unbuffered habitats. It might be expected that these differences in habitat occupancy are linked to the considerable global variation in the habitat availability. However, variation exists between habitat availability and habitat occupancy on both the breeding and non-breeding grounds (excluding the Neotropics) across the three flyways. The Neotropics is the only region where habitat occupancy and habitat availability are correlated. Migrants on the Nearctic and Eastern Palearctic breeding grounds disproportionately favour moderately buffered habitats. On both the breeding and non-breeding grounds of the WP-A flyway, migrants avoid well-buffered habitats, probably as a consequence of the limited amount of forested habitat available to migrants wintering in the Afrotropics, as well as the lack of potential forested stopover-sites for WP-A migrants. On the non-breeding grounds, EP-O migrants favour (scarce) unbuffered habitats, and, similar to their WP-A counterparts, avoid well-buffered habitats.
- Although there is a considerable difference between breeding and non-breeding habitats available to migrants on all three flyways, similarities exist between habitat

use on the breeding and non-breeding grounds on the N-N and EP-O flyways, strongly suggesting that wintering habitat occupancy has some impact on breeding habitat occupancy. Overall, the habitats used by Nearctic and Eastern Palearctic breeding birds better reflects habitat occupancy on the wintering grounds than habitat availability on the breeding grounds. Habitat use on the WP-A flyway differs between the breeding and non-breeding grounds.

- The dietary spectrum of all migrants on the WP-A and EP-O flyways is similar, but differs from the N-N flyway. A large proportion of Old World taxa are obligate insectivores. By contrast, there are considerably more granivorous and frugivorous/nectarivorous migrants in the New World and correspondingly fewer obligate insectivores. Overall, the prevalence of insectivory is least in the Neotropics.
- The prevalence of different foraging modes varies across flyways, with the Orient being intermediate between the Afrotropics and the Neotropics. The dichotomy between large tracts of closed forests in the Neotropics and open savanna-like habitats in the Afrotropics is sufficient to explain the prevalence of vegetation gleaning and perch-and-sally foraging in the Neotropics and of perch-and-pounce and aerial hunters in the Afrotropics.
- The proportion of forest habitat available in the Orient is similar to that in the Neotropics, and there is a diverse array of Palmae and Lauraceae plant families in both areas. For this reason, it was predicted that EP-O birds may show similar patterns in diet and foraging mode to those observed in the Neotropics, with many migrants being frugivorous. However this is not the case: there are no obligate frugivores and very few facultative frugivores among oriental migrants. Indeed, in many comparisons, the Orient grouped more closely with the Afrotropics, the Neotropics being the outlier. If these differences reflect the closer evolutionary history of Western and Eastern Palearctic taxa (relative to the Neotropics), they are likely to have been even more pronounced if analyses had controlled for phylogeny.

Overall, there are several patterns relating to the dispersion and attributes of migratory birds, that are the same on all flyways (Tables 1.2, 3.2). Whilst these provide some predictive capacity, independent of location, they have limited predictive precision. Each flyway has its own particular geographical, biogeographical and historical peculiarities, resulting in many unique regional patterns.

Patterns identified in this study indicate certain fruitful avenues for future research, specifically:

1. Repeating the analyses made here while controlling for phylogeny should allow assessment of whether the EP-O migration system is indeed most similar to that of the WP-A flyway. If this proves to be the case, it may be possible to tease apart with more confidence the relative roles of history and habitat in shaping migration patterns.
2. This study has concentrated solely on the migrant component of bird assemblages, ignoring ecological and distributional attributes of the resident avifauna. The potential role of competition in shaping the behaviour of migrants has thus been ignored. This study does, however, provide a springboard for making such comparisons of ecological complementarity or overlap between residents and migrants.

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Appendices

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APPENDIX 1

List of all landbird taxa occurring on the N-N, WP-A and EP-O flyways. Scientific names (*italics*), common names and order follow Sibley and Monroe (1993). Taxa within the genus *Phylloscopus* follow Irwin *et al.* (2001). (1) indicates taxa occurring on both the WP-A and EP-O flyways. (2) indicates taxa occurring on both the N-N and WP-A flyways. (3) indicates taxa occurring on both the N-N and EP-O flyways.

N-N FLYWAY

PICIDAE

<i>Sphyrapicus varius</i>	Yellow-bellied Sapsucker
<i>Sphyrapicus nuchalis</i>	Red-naped Sapsucker
<i>Sphyrapicus thyroideus</i>	Williamson's Sapsucker
<i>Colaptes auratus auratus</i>	Yellow-shafted Flicker
<i>Colaptes auratus cafer</i>	Red-shafted Flicker

COCCYZIDA

<i>Coccyzus erythrophthalmus</i>	Black-billed Cuckoo
<i>Coccyzus americanus</i>	Yellow-billed Cuckoo

APODIDAE

<i>Cypseloides niger</i>	Black Swift
<i>Chaetura pelagica</i>	Chimney Swift
<i>Chaetura vauxi vauxi</i>	Vaux's Swift
<i>Aeronautes saxatalis</i>	White-throated Swift

TROCHILIDAE

<i>Cynanthus latirostris latirostris</i>	Broad-billed Hummingbird
<i>Amazilia violiceps</i>	Violet-crowned Hummingbird
<i>Lampornis clemenciae</i>	Blue-throated Hummingbird
<i>Eugenes fulgens fulgens</i>	Magnificent Hummingbird
<i>Archilochus colubris</i>	Ruby-throated Hummingbird
<i>Archilochus alexandri</i>	Black-chinned Hummingbird
<i>Calypte anna</i>	Anna's Hummingbird
<i>Calypte costae</i>	Costa's Hummingbird
<i>Stellula calliope</i>	Calliope Hummingbird
<i>Selasphorus platycercus</i>	Broad-tailed Hummingbird
<i>Selasphorus rufus</i>	Rufous Hummingbird
<i>Selasphorus sasin</i>	Allen's Hummingbird

STRIGIDAE

<i>Otus flammeolus</i>	Flammulated Owl
<i>Micrathene whitneyi</i>	Elf Owl
<i>Speotyto cunicularia</i>	Burrowing Owl
<i>Asio otus</i> (3)	Long-eared Owl
<i>Asio flammeus</i> (2) (3)	Short-eared Owl

CAPRIMULGIDAE

<i>Chordeiles acutipennis</i>	Lesser Nighthawk
<i>Chordeiles minor</i>	Common Nighthawk
<i>Phalaenoptilus nuttallii</i>	Common Poorwill
<i>Caprimulgus carolinensis</i>	Chuck-will's-widow
<i>Caprimulgus vociferus arizonae</i>	Stephens's Whip-poor-will
<i>Caprimulgus vociferus vociferus</i>	Eastern Whip-poor-will

COLUMBIDAE

<i>Columba fasciata fasciata</i>	Band-tailed Pigeon
<i>Zenaida macroura</i>	Mourning Dove
<i>Zenaida asiatica asiatica</i>	White-winged Dove

GRUIDAE

<i>Grus canadensis</i>	Sandhill Crane
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SCOLOPACIDAE

<i>Numenius borealis</i>	Eskimo Curlew
<i>Bartramia longicauda</i>	Upland Sandpiper
<i>Tryngites subruficollis</i>	Buff-breasted Sandpiper

CHARADRIIDAE

<i>Pluvialis dominica</i>	Lesser Golden Plover
<i>Charadrius vociferus</i>	Killdeer
<i>Charadrius montanus</i>	Mountain Plover

ACCIPITRIDAE

Elanoides forficatus
Ictinia mississippiensis
Haliaeetus leucocephalus
Circus cyaneus hudsonius
Accipiter striatus
Accipiter cooperii
Buteogallus anthracinus anthracinus
Buteo lineatus
Buteo platypterus
Buteo swainsoni
Buteo albonotatus
Buteo jamaicensis jamaicensis
Buteo regalis
Aquila chrysaetos

FALCONIDAE

Falco sparverius
Falco columbarius (3)
Falco mexicanus
Falco peregrinus (2) (3)

ARDEIDAE

Bubulcus ibis (3)

CICONIIDAE

Cathartes aura

TYRANNIDAE

Camptostoma imberbe
Contopus borealis
Contopus pertinax
Contopus sordidulus
Contopus virens
Empidonax flaviventris
Empidonax virescens
Empidonax alnorum
Empidonax traillii
Empidonax minimus
Empidonax hammondi

Swallow-tailed Kite
Mississippi Kite
Bald Eagle
American Harrier
Sharp-shinned Hawk
Cooper's Hawk
Common Black-Hawk
Red-shouldered Hawk
Broad-winged Hawk
Swainson's Hawk
Zone-tailed Hawk
Red-tailed Hawk
Ferruginous Hawk
Golden Eagle

American Kestrel
Merlin
Prairie Falcon
Peregrine Falcon

Cattle Egret

Turkey Vulture

Northern Beardless Tyrannulet
Olive-sided Flycatcher
Greater Pewee
Western Wood-Pewee
Eastern Wood-Pewee
Yellow-bellied Flycatcher
Acadian Flycatcher
Alder Flycatcher
Willow Flycatcher
Least Flycatcher
Hammond's Flycatcher

Empidonax wrightii
Empidonax oberholseri
Empidonax difficilis difficilis
Empidonax occidentalis
Empidonax fulvifrons
Sayornis phoebe
Sayornis saya
Pyrocephalus rubinus rubinus
Myiarchus tuberculifer tuberculifer
Myiarchus cinerascens
Myiarchus crinitus
Myiarchus tyrannulus magister
Tyrannus vociferans
Tyrannus crassirostris
Tyrannus verticalis
Tyrannus forficata
Tyrannus tyrannus
Myiodynastes luteiventris

LANIIDAE

Lanius ludovicianus

VIREONIDAE

Vireo bellii
Vireo atricapillus
Vireo griseus griseus
Vireo vicinior
Vireo cassinii
Vireo plumbeus
Vireo solitarius
Vireo flavifrons
Vireo philadelphicus
Vireo olivaceus olivaceus
Vireo gilvus

BOMBYCILLIDAE

Bombycilla cedrorum

MUSCICAPIDAE

Sialia sialis

Grey Flycatcher
Dusky Flycatcher
Pacific-slope Flycatcher
Cordilleran Flycatcher
Buff-breasted Flycatcher
Eastern Phoebe
Say's Phoebe
Vermilion Flycatcher
Dusky-capped Flycatcher
Ash-throated Flycatcher
Great Crested Flycatcher
Wied's Crested Flycatcher
Cassin's Kingbird
Thick-billed Kingbird
Western Kingbird
Scissor-tailed Flycatcher
Eastern Kingbird
Sulphur-bellied Flycatcher

Loggerhead Shrike

Bell's Vireo
Black-capped Vireo
White-eyed Vireo
Gray Vireo
Cassin's Vireo
Plumbeous Vireo
Blue-headed Vireo
Yellow-throated Vireo
Philadelphia Vireo
Red-eyed Vireo
Eastern Warbling Vireo

Cedar Waxwing

Eastern Bluebird

Sialia mexicana
Sialia currucoides
Myadestes townsendi
Catharus fuscescens
Catharus minimus minimus
Catharus minimus bicknelli
Catharus ustulatus swainsoni
Catharus ustulatus ustulatus
Catharus guttatus
Catharus mustelinus
Turdus migratorius migratorius

STURNIDAE

Dumetella carolinensis
Oreoscoptes montanus
Toxostoma bendirei
Toxostoma rufum

CERTHIIDAE

Cistothorus platensis stellaris
Troglodytes aedon aedon
Poliophtila caerulea

HIRUNDINIDAE

Tachycineta bicolor
Tachycineta thalassina
Progne subis
Stelgidopteryx serripennis
Riparia riparia riparia (2) (3)
Hirundo rustica erythrogaster
Hirundo pyrrhonota

REGULIDAE

Regulus calendula
Regulus satrapa

ALAUDIDAE

Eremophila alpestris alpestris

PASSERIDAE

Anthus rubescens
Anthus spragueii

Western Bluebird
Mountain Bluebird
Townsend's Solitaire
Veery
Gray-cheeked Thrush
Bicknell's Thrush
Olive-backed Thrush
Russet-backed Thrush
Hermit Thrush
Wood Thrush
American Robin

Gray Catbird
Sage Thrasher
Bendire's Thrasher
Brown Thrasher

Sedge Wren
Northern House-Wren
Blue-gray Gnatcatcher

Tree Swallow
Violet-green Swallow
Purple Martin
Northern Rough-winged Swallow
Common Sand-Martin
Barn Swallow
Cliff Swallow

Ruby-crowned Kinglet
Golden-crowned Kinglet

Horned Lark

American Pipit
Sprague's Pipit

FRINGILLIDAE

Carduelis pinus
Carduelis tristis
Carduelis psaltria
Carduelis lawrencei
Calcarius mccownii
Calcarius ornatus
Carpodacus cassinii
Calamospiza melanocorys
Melospiza melodia
Melospiza lincolni
Melospiza georgiana
Zonotrichia albicollis
Zonotrichia leucophrys
Passerculus sandwichensis sandwichensis
Ammodramus caudacutus
Ammodramus bairdii
Ammodramus savannarum
Spizella passerina
Spizella pallida
Spizella breweri
Spizella pusilla
Spizella atrogularis
Poocetes gramineus
Chondestes grammacus
Amphispiza bilineata
Amphispiza belli nevadensis
Aimophila botterii botterii
Aimophila cassinii
Pipilo chlorurus
Pipilo erythrophthalmus erythrophthalmus
Pipilo erythrophthalmus maculatus
Vermivora bachmanii
Vermivora pinus
Vermivora chrysoptera
Vermivora peregrina

Pine Siskin
American Goldfinch
Lesser Goldfinch
Lawrence's Goldfinch
McCown's Longspur
Chestnut-collared Longspur
Cassin's Finch
Lark Bunting
Song Sparrow
Lincoln's Sparrow
Swamp Sparrow
White-throated Sparrow
White-crowned Sparrow
Savannah Sparrow
Sharp-tailed Sparrow
Baird's Sparrow
Grasshopper Sparrow
Chipping Sparrow
Clay-colored Sparrow
Brewer's Sparrow
Field Sparrow
Black-chinned Sparrow
Vesper Sparrow
Lark Sparrow
Black-throated Sparrow
Sage Sparrow
Botteri's Sparrow
Cassin's Sparrow
Green-tailed Towhee
Eastern Towhee
Spotted Towhee
Bachman's Warbler
Blue-winged Warbler
Golden-winged Warbler
Tennessee Warbler

<i>Vermivora celata</i>	Orange-crowned Warbler	<i>Oporornis agilis</i>	Connecticut Warbler
<i>Vermivora ruficapilla</i>	Nashville Warbler	<i>Oporornis philadelphia</i>	Mourning Warbler
<i>Vermivora virginiae</i>	Virginia's Warbler	<i>Oporornis tolmiei</i>	MacGillivray's Warbler
<i>Vermivora luciae</i>	Lucy's Warbler	<i>Geothlypis trichas trichas</i>	Common Yellowthroat
<i>Parula americana</i>	Northern Parula	<i>Wilsonia citrina</i>	Hooded Warbler
<i>Dendroica petechia aestiva</i>	Yellow Warbler	<i>Wilsonia pusilla</i>	Wilson's Warbler
<i>Dendroica pensylvanica</i>	Chestnut-sided Warbler	<i>Wilsonia canadensis</i>	Canada Warbler
<i>Dendroica magnolia</i>	Magnolia Warbler	<i>Cardellina rubifrons</i>	Red-faced Warbler
<i>Dendroica tigrina</i>	Cape May Warbler	<i>Myioborus pictus</i>	Painted Redstart
<i>Dendroica caerulescens</i>	Black-throated Blue Warbler	<i>Icteria virens</i>	Yellow-breasted Chat
<i>Dendroica coronata coronata</i>	Myrtle Warbler	<i>Piranga flava hepatica</i>	Hepatic Tanager
<i>Dendroica coronata auduboni</i>	Audubon's Warbler	<i>Piranga rubra</i>	Summer Tanager
<i>Dendroica nigrescens</i>	Black-throated Grey Warbler	<i>Piranga olivacea</i>	Scarlet Tanager
<i>Dendroica townsendi</i>	Townsend's Warbler	<i>Piranga ludoviciana</i>	Western Tanager
<i>Dendroica occidentalis</i>	Hermit Warbler	<i>Spiza americana</i>	Dickcissel
<i>Dendroica virens</i>	Black-throated Green Warbler	<i>Pheucticus ludovicianus</i>	Rose-breasted Grosbeak
<i>Dendroica chrysoparia</i>	Golden-cheeked Warbler	<i>Pheucticus melanocephalus</i>	Black-headed Grosbeak
<i>Dendroica fusca</i>	Blackburnian Warbler	<i>Guiraca caerulea</i>	Blue Grosbeak
<i>Dendroica dominica</i>	Yellow-throated Warbler	<i>Passerina amoena</i>	Lazuli Bunting
<i>Dendroica graciae</i>	Grace's Warbler	<i>Passerina cyanea</i>	Indigo Bunting
<i>Dendroica pinus</i>	Pine Warbler	<i>Passerina versicolor</i>	Varied Bunting
<i>Dendroica kirtlandii</i>	Kirtland's Warbler	<i>Passerina ciris pallidior</i>	Western Painted Bunting
<i>Dendroica discolor</i>	Prairie Warbler	<i>Passerina ciris ciris</i>	Eastern Painted Bunting
<i>Dendroica palmarum</i>	Palm Warbler	<i>Icterus galbula bullockii</i>	Bullock's Oriole
<i>Dendroica castanea</i>	Bay-breasted Warbler	<i>Icterus galbula galbula</i>	Baltimore Oriole
<i>Dendroica striata</i>	Blackpoll Warbler	<i>Icterus cucullatus</i>	Hooded Oriole
<i>Dendroica cerulea</i>	Cerulean Warbler	<i>Icterus spurius spurius</i>	Orchard Oriole
<i>Mniotilta varia</i>	Black-and-white Warbler	<i>Icterus parisorum</i>	Scott's Oriole
<i>Setophaga ruticilla</i>	American Redstart	<i>Agelaius phoeniceus</i>	Red-winged Blackbird
<i>Protonotaria citrea</i>	Prothonotary Warbler	<i>Sturnella magna</i>	Eastern Meadowlark
<i>Helmitheros vermivorus</i>	Worm-eating Warbler	<i>Sturnella neglecta</i>	Western Meadowlark
<i>Limnothlypis swainsonii</i>	Swainson's Warbler	<i>Euphagus cyanocephalus</i>	Brewer's Blackbird
<i>Seiurus aurocapillus</i>	Ovenbird	<i>Molothrus aeneus aeneus</i>	Bronzed Cowbird
<i>Seiurus noveboracensis</i>	Northern Waterthrush	<i>Molothrus ater</i>	Brown-headed Cowbird
<i>Seiurus motacilla</i>	Louisiana Waterthrush	<i>Dolichonyx oryzivorus</i>	Bobolink
<i>Oporornis formosus</i>	Kentucky Warbler		

WP-A FLYWAY

PHASIANIDAE

Coturnix coturnix coturnix (1)

PICIDAE

Jynx torquilla (1)

UPUPIDAE

Upupa epops (1)

CORACIIDAE

Coracias garrulus

MEROPIDAE

Merops persicus

Merops apiaster

CUCULIDAE

Clamator glandarius

Cuculus canorus canorus (1)

APODIDAE

Tachymarphs melba

Apus apus

Apus pallidus

STRIGIDAE

Otus scops scops

Asio flammeus (1) (2)

CAPRIMULGIDAE

Caprimulgus ruficollis

Caprimulgus europaeus

Caprimulgus aegyptius

COLUMBIDAE

Streptopelia turtur

GRUIDAE

Grus virgo (1)

Grus grus (1)

RALLIDAE

Crex crex

BURHINIDAE

Burhinus oedicnemus

Eurasian Quail

Eurasian Wryneck

Eurasian Hoopoe

European Roller

Blue-cheeked Bee-Eater

European Bee-Eater

Great Spotted Cuckoo

Common Cuckoo

Alpine Swift

Common Swift

Pallid Swift

Common Scops-Owl

Short-Eared Owl

Red-necked Nightjar

Eurasian Nightjar

Egyptian Nightjar

European Turtle-Dove

Demoiselle Crane

Common Crane

Corn Crake

Eurasian Thick-Knee

CHARADRIIDAE

Charadrius asiaticus

Vanellus vanellus (1)

Vanellus gregarius (1)

GLAREOLIDAE

Glareola pratincola

Glareola nordmanni

ACCIPITRIDAE

Pernis apivorus

Milvus migrans migrans (1)

Neophron percnopterus

Gyps fulvus

Circaetus gallicus gallicus (1)

Circus macrourus (1)

Circus pygargus (1)

Accipiter brevipes

Accipiter nisus (1)

Buteo buteo buteo

Buteo buteo vulpinus (1)

Buteo rufinus (1)

Aquila pomarina

Aquila clanga (1)

Aquila nipalensis orientalis

Aquila heliaca (1)

Hieraaetus pennatus (1)

FALCONIDAE

Falco naumanni

Falco tinnunculus (1)

Falco vespertinus

Falco eleonorae

Falco concolor

Falco subbuteo (1)

Falco cherrug (1)

Falco peregrinus (1) (2)

Caspian Plover

Northern Lapwing

Sociable Lapwing

Collared Pratincole

Black-winged Pratincole

European Honey-Buzzard

Black Kite

Egyptian Vulture

Eurasian Griffon

Short-toed Snake-Eagle

Pallid Harrier

Montagu's Harrier

Levant Sparrowhawk

Eurasian Sparrowhawk

Common Buzzard

Western Steppe-Buzzard

Long-Legged Buzzard

Lesser Spotted Eagle

Greater Spotted Eagle

Western Steppe-Eagle

Imperial Eagle

Booted Eagle

Lesser Kestrel

Common Kestrel

Red-Footed Falcon

Eleonora's Falcon

Sooty Falcon

Eurasian Hobby

Saker Falcon

Peregrine Falcon

Falco pelegrinoides

THRESKIORNITHIDAE

Geronticus eremita

CICONIIDAE

Ciconia ciconia

LANIIDAE

Lanius collurio

Lanius isabellinus phoenicuroides

Lanius minor

Lanius excubitor meridionalis

Lanius senator

Lanius nubicus

CORVIDAE

Oriolus oriolus (1)

MUSCICAPIDAE

Monticola saxatilis

Monticola solitarius solitarius

Turdus philomelos

Muscicapa striata

Ficedula hypoleuca

Ficedula albicollis

Ficedula semitorquata

Luscinia luscinia

Luscinia megarhynchos

Luscinia svecica (1)

Irania gutturalis

Cercotrichas galactotes galactotes

Cercotrichas galactotes familiaris

Phoenicurus ochruros (1)

Phoenicurus phoenicurus

Saxicola rubetra

Saxicola torquata torquata

Saxicola torquata maura (1)

Oenanthe oenanthe oenanthe

Oenanthe hispanica

Oenanthe pleschanka

Barbary Falcon

Waldrap

White Stork

Redbacked Shrike

Rufous-tailed Shrike

Lesser Grey Shrike

Southern Grey Shrike

Woodchat Shrike

Masked Shrike

European Golden Oriole

Rufous-tailed Rock-Thrush

Blue Rock-Thrush

Song Thrush

Spotted Flycatcher

European Pied Flycatcher

Collared Flycatcher

Semicollared Flycatcher

Thrush Nightingale

Common Nightingale

Blue Throat

White-throated Robin

Rufous-tailed Scrub-Robin

Greyish Scrub-Robin

Black Redstart

Common Redstart

Whinchat

Common Stonechat

Siberian Stonechat

Northern Wheatear

Black-eared Wheatear

Pied Wheatear

Oenanthe cypriaca

Oenanthe xanthopyrimna xanthopyrimna

Oenanthe xanthopyrimna chrysopygla (1)

Oenanthe deserti (1)

Oenanthe isabellina (1)

STURNIDAE

Sternus vulgaris (1)

HIRUNDINIDAE

Riparia riparia riparia (1) (2)

Hirundo rupestris (1)

Hirundo rustica rustica (1)

Hirundo daurica rufula

Delichon urbica (1)

SYLVIIDAE

Locustella naevia (1)

Locustella fluviatilis

Locustella luscinioides

Acrocephalus scirpaceus

Acrocephalus palustris

Hippolias pallida

Hippolias languida

Hippolias olivetorum

Hippolais polyglotta

Hippolais icterina

Phylloscopus trochilus

Phylloscopus collybita collybita

Phylloscopus brehmii

Phylloscopus orientalis

Phylloscopus bonelli

Phylloscopus sibilatrix

Sylvia atricapilla

Sylvia borin

Sylvia communis

Sylvia curruca (1)

Sylvia Nana (1)

Sylvia nisoria

Cyprus Wheatear

Rufous-tailed Wheatear

Afghan Wheatear

Desert Wheatear

Isabelline Wheatear

Common Starling

Sand Martin

Eurasian Crag-Martin

Eurasian Swallow

Red-rumped Swallow

Northern House-Martin

Common Grasshopper-Warbler

Eurasian River Warbler

Savi's Warbler

Eurasian Reed-Warbler

Marsh Warbler

Olivaceous Warbler

Upcher's Warbler

Olive-tree Warbler

Melodious warbler

Icterine Warbler

Willow Warbler

Eurasian Chiffchaff

Iberian Chiffchaff

Eastern Bonelli's Warbler

Western Bonelli's Warbler

Wood Warbler

Blackcap

Garden Warbler

Greater White throat

Lesser White-throat

Desert Warbler

Barred Warbler

Sylvia hortensis
Sylvia rueppelli
Sylvia melanocephala
Sylvia cantillans
Sylvia mystacea
Sylvia conspicillata

ALAUDIDAE

Melanocorypha bimaculata
Calandrella brachydactyla (1)
Calandrella rufescens

PASSERIDAE

Passer hispaniolensis
Carpospiza brachydactyla
Motacilla alba alba (1)
Motacilla alba yarrelli
Motacilla flava flavissima
Motacilla flava flava (1)

EP-O FLYWAY

PHASIANIDAE

Coturnix coturnix coturnix (1)
Coturnix japonica

ANATIDAE

Anser erythropus

PICIDAE

Jynx torquilla (1)

UPUPIDAE

Upupa epops (1)

CORACIIDAE

Eurystomus orientalis

HALCYONIDAE

Halcyon coromanda

MEROPIDAE

Merops philippinus

CUCULIDAE

Orphean Warbler
Rueppell's Warbler
Sardinian Warbler
Subalpine warbler
Menetries's Warbler
Spectacled Warbler

Bimaculated Lark
Greater Short-toed Lark
Lesser Short-toed Lark

Spanish Sparrow
Pale Rockfinch
White Wagtail
British Pied Wagtail
Yellowish-crowned Wagtail
Blue-headed Wagtail

Eurasian Quail
Japanese Quail

Lesser White-fronted Goose

Eurasian Wryneck

Eurasian Hoopoe

Dollarbird

Ruddy Kingfisher

Blue-tailed Bee-Eater

Motacilla flava cinereocapilla
Motacilla flava lutea (1)
Motacilla flava feldegg
Motacilla flava thunbergi (1)
Anthus campestris (1)
Anthus trivialis (1)
Anthus pratensis
Anthus cervinus (1)
Anthus spinoletta (1)

FRINGILLIDAE

Carduelis carduelis carduelis
Carduelis cannabina
Emberiza cineracea
Emberiza hortulana
Emberiza caesia
Miliaria calandra

Clamator coromandus
Cuculus sparverioides
Cuculus fugax hyperythrus
Cuculus canorus canorus (1)
Cuculus micropterus
Cuculus saturatus saturatus
Cuculus poliocephalus
Chrysococcyx maculatus
Surniculus lugubris

APODIDAE

Collocalia brevirostris brevirostris
Hirundapus caudacutus
Apus pacificus

STRIGIDAE

Otus brucei
Otus scops sunia

Ashy-headed Wagtail
Yellow-headed Wagtail
Black-headed Wagtail
Grey-headed Wagtail
Tawny Pipit
Tree Pipit
Meadow Pipit
Red-throated Pipit
Water Pipit

European Goldfinch
Eurasian Linnnet
Cinereous Bunting
Ortolan Bunting
Cretzschmar's Bunting
Corn Bunting

Chestnut-winged Cuckoo
Large Hawk-Cuckoo
Northern Hawk-Cuckoo
Common Cuckoo
Indian Cuckoo
Oriental Cuckoo
Lesser Cuckoo
Asian Emerald Cuckoo
Drongo Cuckoo

Himalayan Swiftlet
White-troated Needletail
Fork-tailed Swift

Pallid Scops-Owl
Oriental Scops-Owl

Ninox scutulata scutulata
Asio otus (3)
Asio flammeus (1) (3)
CAPRIMULGIDAE
Caprimulgus indicus
COLUMBIDAE
Streptopelia orientalis
Streptopelia tranquebarica
GRUIDAE
Grus virgo (1)
Grus grus (1)
SCOLOPACIDAE
Scolopax rusticola
Scolopax rusticola
CHARADRIIDAE
Vanellus vanellus (1)
Vanellus gregarius (1)
Charadrius veredus
ACCIPITRIDAE
Aviceda leuphotes
Pernis ptilorhynchus orientalis
Milvus migrans migrans (1)
Aegypius monachus
Circaetus gallicus gallicus (1)
Circus cyaneus cyaneus
Circus macrourus (1)
Circus melanoleucos
Circus pygargus (1)
Accipiter soloensis
Accipiter gularis
Accipiter nisus (1)
Accipiter gentilis gentilis
Butastur indicus
Buteo buteo vulpinus (1)
Buteo buteo japonicus
Buteo rufinus (1)

Brown Hawk-Owl
Long-eared Owl
Short-eared Owl

Grey Nightjar

Oriental Turtle-Dove
Red Collared-Dove

Demoiselle Crane
Common Crane

Eurasian Woodcock
Eurasian Woodcock

Northern Lapwing
Sociable Lapwing
Oriental Plover

Black Baza
Siberian Honey-Buzzard
Black Kite
Cinereous Vulture
Short-toed Snake-Eagle
Hen Harrier
Pallid Harrier
Pied Harrier
Montagu's Harrier
Chinese Goshawk
Japanese Sparrowhawk
Eurasian Sparrowhawk
Eurasian Goshawk
Grey-faced Buzzard
Common Buzzard
Japanese Buzzard
Long-legged Buzzard

Buteo hemilasius
Aquila clanga (1)
Aquila nipalensis nipalensis
Aquila heliaca (1)
Hieraaetus pennatus (1)
FALCONIDAE
Falco tinnunculus (1)
Falco columbarius (3)
Falco subbuteo (1)
Falco cherrug (1)
Falco peregrinus (1) (3)
ARDEIDAE
Bubulcus ibis (3)
LANIIDAE
Lanius tigrinus
Lanius bucephalus
Lanius isabellinus isabellinus
Lanius cristatus cristatus
Lanius cristatus superciliosus
Lanius tephronotus
Lanius sphenocercus
CORVIDAE
Oriolus oriolus (1)
Oriolus chinensis
Coracina melaschista
Pericrocotus roseus
Pericrocotus cantonensis
Pericrocotus divaricatus
Pericrocotus ethologus
Dicrurus macrocercus
Dicrurus leucophaeus longicaudatus
Dicrurus leucophaeus leucophaeus
Terpsiphone paradisi
Terpsiphone atrocaudata
MUSCICAPIDAE
Monticola cinclorhynchus

Upland Buzzard
Greater Spotted Eagle
Eastern Steppe-Eagle
Imperial Eagle
Booted Eagle

Common Kestrel
Merlin
Eurasian Hobby
Saker Falcon
Peregrine Falcon

Cattle Egret

Tiger Shrike
Bull-headed Shrike
Isabelline Shrike
Brown Shrike
Japanese Shrike
Grey-backed Shrike
Chinese Grey Shrike

Eurasian Golden-Oriole
Black-naped Oriole
Black-winged Cuckooshrike
Rosy Minivet
Brown-rumped Minivet
Ashy Minivet
Long-tailed Minivet
Black Drongo
Grey Drongo
Ashy Drongo
Asian Paradise-Flycatcher
Japanese Paradise-Flycatcher

Blue-capped Rock-Thrush

Monticola gularis
Monticola rufiventris
Monticola solitarius philippensis
Zoothera sibirica
Zoothera dauma
Turdus hortulorum
Turdus cardis
Turdus merula merula
Turdus rubrocanus
Turdus feae
Turdus obscurus
Turdus pallidus
Turdus chrysolais
Turdus ruficollis atrogularis
Turdus ruficollis ruficollis
Turdus naumanni eunomus
Turdus naumanni naumanni
Rhinomyias brunneata
Muscicapa griseisticta
Muscicapa sibirica sibirica
Muscicapa dauurica dauurica
Muscicapa ferruginea
Ficedula zanthopygia
Ficedula narcissina
Ficedula mugimaki
Ficedula hodgsonii
Ficedula strophiatea
Ficedula parva albicilla
Ficedula subrubra
Ficedula supercilii
Cyanoptila cyanomelana
Eumyias thalassina
Cyornis rubeculoides
Culicicapa ceylonensis
Erithacus akahige
Luscinia sibilans

White-throated Rock-Thrush
Chestnut-bellied Rock-Thrush
Red-bellied Rock-Thrush
Siberian Thrush
Scaly Thrush
Grey-backed Thrush
Japanese Thrush
Eurasian Blackbird
Chestnut Thrush
Grey-sided Thrush
Eyebrowed Thrush
Pale Thrush
Brown-Headed Thrush
Black-throated Thrush
Red-throated Thrush
Dusky Thrush
Naumann's Thrush
Brown-chested Jungle-Flycatcher
Grey-streaked Flycatcher
Dark-sided Flycatcher
Asian Brown Flycatcher
Ferruginous Flycatcher
Yellow-rumped Flycatcher
Narcissus Flycatcher
Mugimaki Flycatcher
Slaty-backed Flycatcher
Rufous-gorgeted Flycatcher
Red-throated Flycatcher
Kashmir Flycatcher
Ultramarine Flycatcher
Blue-and-White Flycatcher
Verditer Flycatcher
Blue-throated Flycatcher
Grey-headed Canary-Flycatcher
Japanese Robin
Rufous-tailed Robin

Luscinia calliope
Luscinia svecica (1)
Luscinia cyane
Tarsiger cyanurus
Tarsiger cyanurus
Phoenicurus ochruros (1)
Phoenicurus aureus
Phoenicurus frontalis
Saxicola torquata maura (1)
Oenanthe xanthopygna chrysopygia (1)
Oenanthe deserti (1)
Oenanthe isabellina (1)
STURNIDAE
Saroglossa spiloptera
Sturnus sericeus
Sturnus sturninus
Sturnus philippensis
Sturnus roseus
Sturnus vulgaris (1)
Sturnus cineraceus
HIRUNDINIDAE
Riparia riparia riparia (1) (3)
Riparia riparia diluta
Hirundo rupestris (1)
Hirundo rustica rustica (1)
Hirundo smithii filifera
Hirundo daurica daurica
Delichon urbica (1)
Delichon dasypus
ZOSTEROPIDAE
Zosterops erythropleura
SYLVIIDAE
Urosphena squameiceps
Cettia canturians
Cettia diphone
Bradypterus thoracicus

Siberian Rubythroat
Bluethroat
Siberian Blue Robin
Orange-flanked Bush-Robin
Orange-flanked Bush-Robin
Black Redstart
Daurian Redstart
Blue-fronted Redstart
Siberian Stonechat
Afghan Wheatear
Desert Wheatear
Isabelline Wheatear

Spot-Winged Starling
Red-Billed Starling
Purple-Backed Starling
Chestnut-cheeked Starling
Rosy Starling
Common Starling
White-Cheeked Starling

Common Sand-Martin
Eastern Sand-Martin
Eurasian Crag-Martin
Eurasian Swallow
Asian Wire-tailed Swallow
Lesser Striated Swallow
Northern House-Martin
Asian House-Martin

Chestnut-flanked White-Eye

Asian Stubtail
Manchurian Bush-Warbler
Japanese Bush Warbler
Spotted Bush-Warbler

Bradypterus tacsanowskius
Locustella lanceolata
Locustella naevia (1)
Locustella certhiola
Locustella ochotensis
Locustella pleskei
Locustella fasciolata fasciolata
Locustella fasciolata amnicola
Acrocephalus bistrigiceps
Acrocephalus dumetorum
Acrocephalus aedon
Hippolais caligata
Phylloscopus collybita tristis
Phylloscopus collybita sibiricus
Phylloscopus fuscatus
Phylloscopus affinis
Phylloscopus subaffinis
Phylloscopus griseolus
Phylloscopus armandii
Phylloscopus schwarzi
Phylloscopus pulcher
Phylloscopus proregulus
Phylloscopus chloronotus
Phylloscopus inornatus inornatus
Phylloscopus inornatus humei
Phylloscopus borealis
Phylloscopus trochiloides trochiloides
Phylloscopus trochiloides plumbeitarsus
Phylloscopus tenellipes
Phylloscopus borealoides
Phylloscopus magnirostris
Phylloscopus tytleri
Phylloscopus occipitalis
Phylloscopus coronatus
Phylloscopus ijimae
Phylloscopus reguloides

Chinese Bush-Warbler
 Lanceolated Warbler
 Common Grasshopper-Warbler
 Pallas's Grasshopper-Warbler
 Middendorff's Grasshopper-Warbler
 Pleske's Grasshopper Warbler
 Gray's Grasshopper-Warbler
 Sakhalin Grasshopper-Warbler
 Black-browed Reed-Warbler
 Blyth's Reed-Warbler
 Thick-billed Warbler
 Booted Warbler
 Siberian Chiffchaff
 Mountain Chiffchaff
 Dusky Warbler
 Tickell's Leaf-Warbler
 Buff-throated Warbler
 Sulphur-bellied Warbler
 Yellow-streaked Warbler
 Radde's Warbler
 Buff-barred Warbler
 Yellow-rumped Warbler
 Pale-rumped Warbler
 Yellow-browed Warbler
 Buff-browed Warbler
 Arctic Warbler
 Greenish Warbler
 Two-barred Warbler
 Pale-legged Leaf-Warbler
 Sakhalin Leaf-Warbler
 Large-billed Leaf-Warbler
 Tytler's Leaf-Warbler
 Western Crowned-Warbler
 Eastern Crowned-Warbler
 Ijima's Leaf-Warbler
 Blyth's Leaf-Warbler

Phylloscopus davisoni
Phylloscopus ricketti
Seicercus burkii
Sylvia curruca (1)
Sylvia nana (1)

ALAUDIDAE

Calandrella brachydactyla (1)
Calandrella acutirostris

PASSERIDAE

Petronia xanthocollis
Dendronanthus indicus
Motacilla alba alba (1)
Motacilla alba personata
Motacilla flava flava (1)
Motacilla flava leucocephala
Motacilla flava lutea (1)
Motacilla flava melanogrisea
Motacilla flava thunbergi (1)
Motacilla flava taivana
Motacilla flava simillima
Motacilla flava tschutschensis
Motacilla cinerea
Anthus richardi
Anthus campestris (1)
Anthus godlewskii
Anthus similis similis
Anthus trivialis (1)
Anthus hodgsoni
Anthus gustavi gustavi
Anthus gustavi menzbieri
Anthus cervinus (1)
Anthus roseatus
Anthus spinoletta (1)

FRINGILLIDAE

Fringilla montifringilla
Carduelis spinus

White-tailed Leaf-Warbler
 Sulphur-breasted Warbler
 Golden-Spectacled Warbler
 Lesser Whitethroat
 Desert Warbler

Greater Short-toed Lark
 Hume's Lark

Chestnut-shouldered Petronia
 Forest Wagtail
 White Wagtail
 Masked Wagtail
 Blue-headed Wagtail
 White-headed Wagtail
 Yellow-headed Wagtail
 White-chinned Wagtail
 Grey-headed Wagtail
 Green-headed Wagtail
 Siberian Yellow Wagtail
 Alaska Yellow Wagtail
 Grey Wagtail
 Richard's Pipit
 Tawny Pipit
 Blyth's Pipit
 Long-billed Pipit
 Tree Pipit
 Olive-Backed Pipit
 Pechora Pipit
 Menzbier's Pipit
 Red-throated Pipit
 Rosy Pipit
 Water Pipit

Brambling
 Eurasian Siskin

Carpodacus erythrinus
Coccothraustes coccothraustes
Eophonia migratoria
Eophonia personata
Emberiza stewarti
Emberiza buchanani
Emberiza tristrami
Emberiza fucata
Emberiza pusilla
Emberiza chrysophrys
Emberiza rustica
Emberiza elegans

Common Rosefinch
Hawfinch
Yellow-billed Grosbeak
Japanese Grosbeak
Chestnut-breasted Bunting
Grey-necked Bunting
Tristram's Bunting
Chestnut-eared Bunting
Little Bunting
Yellow-browed Bunting
Rustic Bunting
Yellow-throated Bunting

Emberiza aureola
Emberiza rutila
Emberiza bruniceps
Emberiza sulphurata
Emberiza spodocephala
Emberiza schoeniclus schoeniclus
Emberiza pallasi pallasi
REGULIDAE
Regulus regulus
CISTICOLIDAE
Cisticola juncidis

Yellow-breasted Bunting
Chestnut Bunting
Red-headed Bunting
Yellow Bunting
Black-faced Bunting
Northern Reed-Bunting
Pallas's Bunting

Goldcrest

Zitting Cisticola

University of Cape Town

APPENDIX 2

Distribution, mean body mass (grams), habitat preferences, dietary preferences and foraging mode of Holarctic-breeding migrants on each of the three major migratory flyways, the N-N, WP-A and EP-O flyways. (1) indicates taxa occurring on both the WP-A and EP-O flyways, (2) indicates taxa occurring on both the N-N and WP-A flyways, and (3) indicates taxa occurring on both the N-N and EP-O flyways. Distribution data include northern and southern limits of both the breeding (BR) and non-breeding (NBR) ranges. For mean body mass (g): 1 = ≤30g, 2 = 31-100g and 3 = >100g. For habitat preferences during the breeding and non-breeding seasons: WB = well-buffered, MB = moderately buffered, UB = unbuffered and D = diverse. Diet abbreviations are: V = vertebrates, I = invertebrates, S = seeds, F = fruit/nectar, P = plant matter and G = generalist. Foraging mode abbreviations are: A = aerial, S = perch-and-sally, P = pounce, V = vegetation gleaning and G = ground gleaning. Superscript numbers indicate references.

N-N FLYWAY

Scientific name	Distribution				Mean body mass	Habitat		Diet		Foraging mode
	BR range		NBR range			BR	NBR	BR	NBR	
	N limit	S limit	N limit	S limit						
PICIDAE										
<i>Sphyrapicus varius</i>	64 N ^{11,25}	35 N ¹¹	40 N ^{11,25}	8 N ²⁵	2 ^{11,25}	WB	D 22,25	IF	IF 25	V 25
<i>Sphyrapicus nuchalis</i>	54 N ¹¹	32 N ¹¹	35 N ^{11,25}	20 N ²⁵	2 ^{11,25}	WB	WB 25	IF	IF 1,25	V 25
<i>Sphyrapicus thyroideus</i>	50 N ^{11,25}	33 N ¹¹	35 N ²⁵	19 N ²⁵	2 ^{11,25}	WB	WB 25	IF	IF 25	V 25
<i>Colaptes auratus auratus</i>	70 N ^{11,22}	25 N ²²	53 N ^{11,22}	24 N ²⁵	3 ^{5,11,25}	D	WB 22,25	I	I 16,25,28	VG 16,25,28
<i>Colaptes auratus cafer</i>	62 N ^{17,22}	25 N ²²	53 N ^{11,22}	25 N ²²	3 ^{11,25}	D	WB 22,25	I	I 16,25,28	VG 16,25,28
COCCYZIDA										
<i>Coccyzus erythrophthalmus</i>	54 N ¹¹	34 N ¹¹	12 N ¹	20 S ¹	2 ^{1,11}	D	D 1,22	I	I 1,16	V 1,16
<i>Coccyzus americanus</i>	48 N ¹	18 N ¹	12 N ¹	35 S ¹	2 ^{1,11}	D	D 1,22	I	I 1,16	V 1,16
APODIDAE										
<i>Cypseloides niger</i>	55 N ¹	10 N ¹	17 N ^{6,22}	2 N ^{6,22}	2 ^{1,11}	D	D 1,6	I	I 1,6,16	A 6,16
<i>Chaetura pelagica</i>	55 N ¹¹	25 N ¹¹	0 ^{1,6}	23 S ^{1,6}	1 ⁶	D	D 1,6,22	I	I 1,6,16	A 1,6,16
<i>Chaetura vauxi vauxi</i>	58 N ^{6,11}	35 N ^{6,11}	24 N ⁶	17 N ⁶	1 ^{5,11}	WB	WB 1,6,22	I	I 16,28	A 16,28
<i>Aeronautes saxatalis</i>	50 N ¹¹	13 N ^{1,6}	39 N ¹¹	13 N ^{1,6}	2 ^{1,5}	D	D 1,6,22	I	I 16,28	A 16,28

TROCHILIDAE

<i>Cyananthus latirostris latirostris</i>	33 N ²⁴	17 N ²⁴	27 N ²⁴	17 N ²⁴	1 ¹¹	MB MB	1,22,24	F F	1,24,28	V	24,28
<i>Amazilia violiceps</i>	32 N ^{11,24}	18 N ²⁴	25 N ²⁴	18 N ²⁴	1 ^{11,24}	MB MB	1,22,24	F F	1,24	V	1,24,28
<i>Lampornis clemenciae</i>	33 N ^{11,24}	17 N ²⁴	28 N ²⁴	17 N ²⁴	1 ^{11,24}	WB WB	1,22,24	IF IF	24	VS	1,24,28
<i>Eugenes fulgens fulgens</i>	33 N ^{11,24}	11 N ²⁴	30 N ²²	11 N ²²	1 ^{11,24}	WB WB	1,22,24	F F	1,24,28	V	1,24
<i>Archilochus colubris</i>	54 N ^{11,24}	27 N ²⁴	22 N ²⁴	10 N ²⁴	1 ^{11,24}	WB WB	1,22,24	F IF	1,24	VS	1,24
<i>Archilochus alexandri</i>	51 N ^{11,24}	25 N ^{11,24}	27 N ²⁴	18 N ²⁴	1 ^{11,24}	MB MB	1,22,24	F F	1,24,28	V	1,24,28
<i>Calypte anna</i>	50 N ^{11,22}	30 N ^{11,22}	50 N ^{11,22}	27 N ²⁴	1 ^{11,24}	MB MB	1,22,24	F F	1,24,28	V	1,24,28
<i>Calypte costae</i>	41 N ²⁴	30 N ²⁴	28 N ²⁴	21 N ²⁴	1 ^{11,24}	MB MB	1,22,24	F F	1,24,28	V	1,24
<i>Stellula calliope</i>	56 N ^{11,24}	31 N ^{11,24}	24 N ²⁴	17 N ²⁴	1 ^{11,24}	D D	1,22,24	F F	1,24	V	1,24,28
<i>Selasphorus platycercus</i>	46 N ¹¹	15 N ²²	30 N ²²	14 N ²²	1 ^{11,24}	MB MB	1,22,24	F F	1,24	V	1,24,28
<i>Selasphorus rufus</i>	61 N ^{11,24}	38 N ²⁴	32 N ^{1,24}	16 N ²⁴	1 ^{11,24}	MB MB	1,22,24	F F	1,24	V	1,24,28
<i>Selasphorus sasin</i>	44 N ¹¹	33 N ^{11,24}	20 N ²⁴	18 N ²⁴	1 ^{11,24}	MB MB	1,22	F F	1,24	V	1,24,28

STRIGIDAE

<i>Otus flammeolus</i>	51 N ¹¹	24 N ¹	24 N ^{1,22}	13 N ¹	2 ^{5,11,19}	WB WB	1,19	I I	1,16,19	S	1,16
<i>Micrathene whitneyi</i>	38 N ^{1,11}	24 N ^{1,11}	30 N ¹	19 N ¹	2 ^{11,19}	D D	1,19	I I	16,19	P	1,16,19
<i>Speotyto cunicularia</i>	52 N ^{1,11}	32 N ^{1,11}	32 N ^{1,11}	15 N ¹	3 ^{11,19}	UB UB	19	VI VI	1,16,19	PG	1,16,19
<i>Asio otus (3)</i>	55 N ¹¹	30 N ^{11,22}	48 N ^{1,11,22}	16 N ¹	3 ^{1,11}	WB WB	19	V V	19	P	1,19
<i>Asio flammeus (2) (3)</i>	70 N ^{1,11}	37 N ^{1,11,22}	50 N ^{11,22}	18 N ^{1,22}	3 ^{11,19}	UB UB	1,19	V V	19	P	1,19

CAPRIMULGIDAE

<i>Chordeiles acutipennis</i>	38 N ^{1,26}	20 N ²⁶	25 N ^{1,26}	5 N ^{1,26}	2 ^{1,11}	UB UB	1,26	I I	1,26	A	1,26
<i>Chordeiles minor</i>	64 N ^{1,11}	8 N ^{1,26}	13 N ^{1,27}	40 S ^{1,27}	2 ^{11,26}	UB UB	1,26	I I	1,26	A	1,26
<i>Phalaenoptilus nuttallii</i>	52 N ¹¹	20 N ²⁶	34 N ^{1,26}	20 N ^{1,26}	2 ^{1,11}	MB MB	1,26	I I	1,26	S	26
<i>Caprimulgus carolinensis</i>	43 N ²⁶	25 N ²⁶	31 N ²⁶	4 N ^{1,26}	3 ^{1,11}	WB WB	26	I I	1,26	A	1,26
<i>Caprimulgus vociferus arizonae</i>	39 N ²⁶	20 N ²⁶	27 N ²⁶	19 N ²⁶	2 ^{11,25}	WB WB	1,26	I I	1,26	A	1,26
<i>Caprimulgus vociferus vociferus</i>	50 N ²⁶	33 N ²⁶	34 N ²⁶	13 N ²⁶	2 ^{11,26}	WB WB	1,26	I I	1,26	A	1,26

COLUMBIDAE

<i>Columba fasciata fasciata</i>	55 N ¹	29 N ^{1,11}	40 N ¹	16 N ¹	3 ^{1,11}	WB WB	1,59	P P	1,16,59	GV	16,28,59
<i>Zenaida macroura</i>	54 N ^{1,11,59}	34 N ^{1,59}	28 N ^{1,59}	10 N ^{1,59}	3 ^{1,11}	MB MB	1,59	G G	1,59	G	1,16,59
<i>Zenaida asiatica asiatica</i>	38 N ¹¹	13 N ¹	32 N ¹	13 N ¹	3 ^{1,11}	D D	1,59	P P	1,59	G	16,28,59

GRUIDAE

<i>Grus canadensis</i>	75 N ^{1,11,53}	40 N ^{1,11}	40 N ^{1,11,53}	18 N ²²	3 ¹	UB UB	1,53	G G	1,53	G	1,53
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SCOLOPACIDAE

<i>Numenius borealis</i>	70 N ^{1,54}	66 N ^{1,54}	27 S ^{1,54}	39 S ^{1,54}	- -	UB UB	1,28	I I	1,28	G	28
<i>Bartramia longicauda</i>	70 N ¹¹	35 N ¹¹	18 S ^{1,54}	40 S ^{1,54}	3 ^{1,5}	UB UB	1,54	I I	1,16,28	G	16,28
<i>Tryngites subruficollis</i>	77 N ¹¹	68 N ¹¹	22 N ^{1,54}	39 S ^{1,54}	2 ^{5,11}	UB UB	1,22,54	I I	1,16,28	G	1,16,28

CHARADRIIDAE

<i>Pluvialis dominica</i>	75 N ^{1,54}	59 N ^{1,54}	10 N ^{1,22,54}	37 S ^{22,54}	3 ^{1,5,11}	UB UB	1,22,54	I I	1,16,28	G	16,28
<i>Charadrius vociferus</i>	70 N ¹¹	27 N ^{1,11}	58 N ^{1,11,54}	3 S ^{1,54}	2 ^{1,5,11}	UB UB	1,54	I I	1,16,28	G	1,16,28
<i>Charadrius montanus</i>	52 N ^{1,54}	36 N ^{1,54}	42 N ^{1,54}	25 N ^{1,54}	3 ^{1,5,11}	UB UB	1,22,54	I I	1,16,28	G	16,28

ACCIPITRIDAE

<i>Elanoides forficatus</i>	40 N ^{1,11}	9 N ¹	10 N ¹	22 S ¹	3 ¹¹	WB WB	1,13,15	VI VI	1,13,16	A	1,13,16
<i>Ictinia mississippiensis</i>	40 N ^{1,11}	28 N ^{1,11}	20 S ¹	30 S ¹	3 ^{1,11}	D D	1,13	VI VI	1,13,16	A	1,13,16
<i>Haliaeetus leucocephalus</i>	70 N ^{1,11,14}	41 N ^{1,14}	61 N ¹⁴	25 N ¹¹	3 ^{1,11,14}	D D	1,13	V V	1,13,16,28	P	13,14,16
<i>Circus cyaneus hudsonius</i>	70 N ^{1,11}	32 N ^{1,11}	60 N ^{1,11}	5 N ¹	3 ^{1,11}	UB UB	1,13	V V	1,13	P	1,13
<i>Accipiter striatus</i>	70 N ^{1,11}	17 N ^{1,22}	60 N ^{1,11,22}	7 N ¹	3 ^{1,11}	WB WB	1,22,14,13	V V	1,13	A	1,13,16,28
<i>Accipiter cooperii</i>	50 N ^{1,11}	42 N ¹¹	43 N ¹¹	12 N ¹	3 ^{1,11}	WB WB	1,14,13	V V	1,13	A	1,13,16,28
<i>Buteogallus anthracinus anthracinus</i>	40 N ^{1,11}	2 N ¹	25 N ¹	2 N ¹	3 ^{1,11}	WB WB	1,13	V V	1,13	P	1,16,28
<i>Buteo lineatus</i>	47 N ^{11,14}	25 N ¹⁴	43 N ^{11,14}	25 N ¹⁴	3 ^{1,11,14}	WB WB	1,22,14,13	VI VI	1,13,14,28	P	1,13,14,16
<i>Buteo platypterus</i>	57 N ^{1,11}	30 N ^{1,11}	15 N ¹	20 S ¹	3 ^{1,11}	WB WB	1,13	V VI	1,13	P	1,13,16
<i>Buteo swainsoni</i>	70 N ^{1,11}	25 N ^{1,11}	20 N ¹	40 S ¹	3 ^{1,11}	D D	1,13	V I	1,13	P	1,13,16
<i>Buteo albonotatus</i>	36 N ^{11,14}	24 S ¹	27 N ¹¹	24 S ¹	3 ^{1,11}	D D	1,11,14,13	V V	1,13,14,28	P	1,13,16,28
<i>Buteo jamaicensis jamaicensis</i>	70 N ^{1,11}	23 N ¹⁴	50 N ^{1,14}	8 N ^{1,14}	3 ^{1,11}	D D	1,12,13	V V	1,13	P	1,13,16
<i>Buteo regalis</i>	52 N ¹¹	36 N ^{11,14}	44 N ^{11,14}	19 N ¹⁴	3 ^{1,11}	UB UB	1,13	V V	1,13,16	P	1,13,16
<i>Aquila chrysaetos</i>	70 N ^{1,11,14}	20 N ¹⁴	57 N ¹¹	20 N ^{1,14}	3 ^{1,11}	UB UB	1,14,13	V V	1,13	P	1,13

FALCONIDAE

<i>Falco sparverius</i>	68 N ^{1,11}	18 N ^{11,14}	53 N ^{1,11,14}	8 N ^{1,14}	3 ^{1,11}	UB UB	1,12,13	I V	12,13,15	P	1,13,16,28
<i>Falco columbarius (3)</i>	70 N ^{11,14}	41 N ^{11,14}	53 N ^{11,14}	1 S ¹	3 ^{1,11}	D D	1,13	V V	1,13,16	A	1,13,16,28
<i>Falco mexicanus</i>	53 N ^{11,14}	31 N ¹⁴	50 N ¹⁴	19 N ¹⁴	3 ^{1,11}	UB UB	1,28,14,13	V V	1,13,14,28	AP	1,13,16,28
<i>Falco peregrinus (2) (3)</i>	74 N ^{1,11}	22 N ^{11,14}	52 N ^{1,11,14}	35 S ¹	3 ^{1,11}	D D	12,13	V V	1,13,16	A	1,13,16

ARDEIDAE

<i>Bubulcus ibis (3)</i>	50 N ²²	35 S ^{2,56}	34 N ^{11,22}	35 S ^{2,56}	3 ^{1,11}	UB UB	1,56	VI VI	1,56	G	1,28
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CICONIIDAE

<i>Cathartes aura</i>	51 N ^{1,11}	25 S ^{1,22}	36 N ^{1,11}	25 S ^{1,22}	3 ^{1,11}	D D	1	V V	1	G	1,12
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TYRANNIDAE

<i>Camptostoma imberbe</i>	33 N ¹¹	10 N ²²	29 N ¹¹	10 N ²²	1 ⁵	MB MB	11,17,22			16,28	S	16,28
<i>Contopus borealis</i>	66 N ¹¹	32 N ¹¹	18 N ²²	16 S ²¹	2 ^{5,11}	WB WB	22			16,28	S	16,28
<i>Contopus pertinax</i>	35 N ¹¹	12 N ²²	27 N ¹¹	12 N ²²	1 ^{5,11}	WB WB	11,17,22			16,28	S	16,28
<i>Contopus sordidulus</i>	65 N ¹¹	14 N ²²	10 N ²²	15 S ²¹	1 ^{5,11}	WB WB	11,17,22,28			16,28	S	16,28
<i>Contopus virens</i>	51 N ¹¹	30 N ¹¹	10 N ²²	12 S ²¹	1 ^{5,11}	WB WB	21,22,27			16,28	S	16,28
<i>Empidonax flaviventris</i>	64 N ¹¹	41 N ¹¹	24 N ^{11,22}	8 N ²²	1 ^{5,11}	WB WB	11,22			16,28	S	16,28
<i>Empidonax virescens</i>	43 N ¹¹	30 N ¹¹	15 N ²²	4 S ²¹	1 ^{5,11}	WB WB	11,21,22			16,28	S	16,28
<i>Empidonax alnorum</i>	70 N ¹¹	37 N ¹¹	12 N ²²	25 S ²¹	1 ^{5,11}	MB MB	11,21,22			16,28	S	16,28
<i>Empidonax traillii</i>	53 N ¹¹	33 N ¹¹	20 N ²²	8 N ²²	1 ^{5,11}	MB MB	11,17,22			16,28	S	16,28
<i>Empidonax minimus</i>	64 N ¹¹	35 N ¹¹	27 N ¹¹	8 N ²²	1 ^{5,11}	WB D	11,17,22			16,28	S	16,28
<i>Empidonax hammondii</i>	66 N ¹¹	35 N ¹¹	33 N ¹¹	13 N ²²	1 ^{5,11}	WB WB	22			16,28	S	16,28
<i>Empidonax wrightii</i>	50 N ¹¹	33 N ¹¹	33 N ¹¹	17 N ²²	1 ^{5,11}	MB MB	11,17,22			16,28	S	16,28
<i>Empidonax oberholseri</i>	62 N ^{11,22}	35 N ¹¹	31 N ¹¹	16 N ²²	1 ^{5,11}	MB MB	11,22			16,28	S	16,28
<i>Empidonax difficilis difficilis</i>	58 N ¹¹	30 N ¹¹	29 N ¹¹	16 N ²²	1 ^{5,11}	WB WB	11,17,22			16,28	S	16,28
<i>Empidonax occidentalis</i>	46 N ¹¹	16 N ¹⁷	29 N ¹¹	16 N ⁵⁷	1 ¹¹	WB WB	11,17			11,16,28	S	11,16,28
<i>Empidonax fulvifrons</i>	32 N ¹¹	13 N ²²	28 N ^{11,22}	13 N ²²	1 ^{5,11}	WB WB	11,17,22			16,28	S	16,28
<i>Sayornis phoebe</i>	65 N ¹¹	30 N ¹¹	38 N ¹¹	17 N ²²	1 ^{5,11}	MB MB	11,17,22,28			16,28	S	16,28
<i>Sayornis saya</i>	69 N ¹¹	20 N ²²	40 N ¹¹	17 N ²²	1 ^{5,11}	UB UB	11,17,22			16,28	S	16,28
<i>Pyrocephalus rubinus rubinus</i>	38 N ¹¹	15 N ¹⁷	33 N ^{11,22}	15 N ²²	1 ^{5,11}	MB MB	11,17,22			16,28	S	16,28
<i>Myiarchus tuberculifer tuberculifer</i>	34 N ²²	8 N ²²	28 N ²²	8 N ²²	1 ^{5,11}	WB WB	11,22			16,28	S	16,28
<i>Myiarchus cinerascens</i>	47 N ^{11,22}	18 N ²²	35 N ²²	10 N ²²	1 ^{5,11}	MB MB	11,17,22			16,28	S	16,28
<i>Myiarchus crinitus</i>	56 N ¹¹	25 N ¹¹	28 N ^{11,22}	0 ²¹	2 ^{5,11}	WB WB	21,22			16,28	S	16,28
<i>Myiarchus tyrannulus magister</i>	39 N ^{11,17}	13 N ¹⁷	28 N ¹¹	13 N ²²	2 ^{5,11}	WB WB	11,17,22			16,28	S	16,28
<i>Tyrannus vociferans</i>	39 N ¹¹	16 N ²²	34 N ¹¹	13 N ²²	2 ^{5,11}	MB MB	11,17,22			16,28	S	16,28
<i>Tyrannus crassirostris</i>	31 N ¹¹	17 N ²²	28 N ²²	15 N ²²	2 ^{5,11}	MB MB	11,17,22			28	S	16,28
<i>Tyrannus verticalis</i>	53 N ¹¹	27 N ¹¹	27 N ²²	8 N ²²	2 ^{5,11}	MB MB	17,22			28	S	16,28
<i>Tyrannus forficata</i>	40 N ¹¹	25 N ¹¹	27 N ¹¹	10 N ²²	2 ^{5,11}	MB MB	11,17,22			28	S	16,28
<i>Tyrannus tyrannus</i>	66 N ¹¹	25 N ¹¹	15 N ²²	30 S ²¹	2 ^{5,11}	MB WB	17,21,22		F	21,28	VS	16,28
<i>Myiodynastes luteiventris</i>	33 N ^{11,22}	10 N ²²	10 N ²²	18 S ²¹	2 ^{5,11}	WB WB	21,22			21,28	S	16,28
LANIIDAE												
<i>Lanius ludovicianus</i>	56 N ^{10,11}	36 N ¹⁰	40 N ¹⁰	16 N ²²	2 ¹¹	MB MB	10,11,22	VI	VI	10,16	P	10,16

VIREONIDAE

<i>Vireo bellii</i>	47 N ¹¹	23 N ²²	28 N ^{11,15}	13 N ²²	1 ¹¹	MB MB	11,17,22	I	I	11,16,28	V	11,16,28
<i>Vireo atricapillus</i>	36 N ¹¹	25 N ¹⁵	25 N ¹¹	16 N ²²	1 ¹¹	MB MB	11,17,22	I	IF	16,28	V	11,16,28
<i>Vireo griseus griseus</i>	44 N ¹¹	20 N ²²	34 N ¹¹	13 N ²²	1 ⁵	MB MB	11,17,22	I	IF	16,28	V	16,28
<i>Vireo vicinior</i>	40 N ¹¹	28 N ¹¹	35 N ¹¹	23 N ¹¹	1 ^{5,11}	MB MB	11,17,22,28	I	IF	16,28	V	16,28
<i>Vireo cassinii</i>	56 N ¹¹	34 N ¹¹	33 N ¹¹	15 N ¹⁷	1 ¹¹	WB WB	11,15,17,28	I	I	11,28	V	28
<i>Vireo plumbeus</i>	46 N ¹¹	13 N ¹⁷	28 N ¹¹	13 N ¹⁷	1 ¹¹	WB WB	11,17,28	I	I	11,28	V	28
<i>Vireo solitarius</i>	63 N ¹¹	35 N ¹¹	37 N ¹¹	9 N ²²	1 ⁵	WB WB	22,28	I	IF	16,28	V	16,28
<i>Vireo flavifrons</i>	50 N ¹¹	28 N ¹¹	26 N ²²	2 N ²¹	1 ⁵	WB WB	11,17,22,28	I	I	28	V	28
<i>Vireo philadelphicus</i>	60 N ¹¹	44 N ¹¹	22 N ²²	7 N ²²	1 ^{5,11}	WB WB	11,17,22	I	I	16,28	V	16,28
<i>Vireo olivaceus olivaceus</i>	68 N ¹¹	28 N ¹¹	12 N ²²	30 S ²¹	1 ⁵	WB WB	11,17,22	I	F	16,21,28	V	16,28
<i>Vireo gilvus</i>	66 N ¹¹	17 N ²²	27 N ^{11,22}	13 N ²²	1 ⁵	WB WB	22,28	I	I	16,28	V	16,28

BOMBYCILLIDAE

<i>Bombycilla cedrorum</i>	60 N ¹¹	35 N ¹¹	51 N ¹¹	7 N ²²	2 ^{5,11}	WB WB	17,22	F	F	16,28	V	16,28
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MUSCICAPIDAE

<i>Sialia sialis</i>	51 N ¹¹	12 N ²²	36 N ¹¹	12 N ²²	2 ^{5,11}	WB WB	17,22	IF	IF	16,28	VS	16,28
<i>Sialia mexicana</i>	53 N ¹¹	18 N ²²	50 N ^{11,22}	18 N ²²	1 ^{5,11}	WB WB	17,22	IF	IF	16,28	VS	16,28
<i>Sialia currucoides</i>	68 N ¹¹	34 N ¹¹	46 N ¹¹	19 N ²²	1 ^{5,11}	WB D	17,22	I	IF	16,28	P	16,28
<i>Myadestes townsendi</i>	70 N ¹¹	20 N ²²	51 N ^{11,22}	20 N ²²	2 ^{5,11}	WB D	22	IF	IF	16,28	VS	16,28
<i>Catharus fuscescens</i>	56 N ¹¹	34 N ¹¹	12 N ²²	23 S ²¹	2 ^{5,11}	WB WB	21,22	IF	IF	16,28	VG	16,28
<i>Catharus minimus minimus</i>	71 N ^{11,17}	47 N ^{11,17}	12 N ^{17,21}	6 N ²¹	2 ^{5,11}	WB WB	22,35	I	IF	16,28,35	G	16,28,35
<i>Catharus minimus bicknelli</i>	49 N ¹¹	43 N ¹¹	20 N ¹⁷	18 N ¹⁷	1 ¹¹	WB WB	22,35	I	IF	16,28,35	G	16,28,35
<i>Catharus ustulatus swainsoni</i>	68 N ^{11,17}	34 N ^{11,17}	12 N ^{17,21}	27 S ²¹	2 ¹¹	WB WB	17,22,35	I	IF	16,21,28,35	VG	16,28,35
<i>Catharus ustulatus ustulatus</i>	66 N ¹⁷	33 N ¹⁷	23 N ²²	7 N ¹⁷	1 ^{5,11}	WB WB	17,22,35	I	IF	16,21,28,35	VG	16,28,35
<i>Catharus guttatus</i>	66 N ¹¹	30 N ¹¹	50 N ¹¹	13 N ²²	2 ^{5,11}	WB WB	17,22,35	I	IF	16,28	VG	16,28,35
<i>Catharus mustelinus</i>	49 N ¹¹	30 N ¹¹	27 N ^{17,22}	7 N ^{17,22}	2 ^{5,11}	WB WB	22	IF	IF	16,28	G	16,28
<i>Turdus migratorius migratorius</i>	70 N ¹¹	17 N ^{17,22}	53 N ¹¹	17 N ²²	2 ^{5,11}	D D	17,22	IF	IF	16,28	G	16,28

STURNIDAE

<i>Dumetella carolinensis</i>	58 N ¹¹	30 N ¹¹	52 N ^{11,22}	7 N ²²	2 ⁵	MB MB	11,22	IF	IF	16,28	G	16,28
<i>Oreoscoptes montanus</i>	51 N ¹¹	35 N ¹¹	36 N ¹¹	20 N ²²	2 ^{5,11}	MB MB	11,17,22	IF	IF	16,28	G	16,28
<i>Toxostoma bendirei</i>	39 N ¹¹	23 N ²²	34 N ¹¹	23 N ²²	2 ¹¹	UB UB	11,22,28	I	I	16,28	G	16,28
<i>Toxostoma rufum</i>	54 N ¹¹	25 N ^{11,22}	40 N ^{11,22}	25 N ^{11,22}	2 ¹¹	MB MB	11,22,28	IF	IF	16,28	G	11,16,28

CERTHIIDAE

<i>Cistothorus platensis stellaris</i>	56 N ¹¹	37 N ¹¹	37 N ¹¹	22 N ²²	1 ^{5,11}	UB	UB	11,17,22	I	I	16,28	VG	16,28
<i>Troglodytes aedon aedon</i>	60 N ¹¹	30 N ²²	38 N ¹¹	16 N ²²	1 ^{5,11}	MB	MB	11,17,22	I	I	16,28	VG	16,28
<i>Polioptila caerulea</i>	47 N ¹¹	13 N ²²	35 N ¹¹	13 N ²²	1 ^{5,11}	D	D	22	I	I	16,28	V	16,28

HIRUNDINIDAE

<i>Tachycineta bicolor</i>	68 N ¹¹	34 N ¹¹	36 N ¹¹	13 N ⁸	1 ^{8,11}	D	D	8,22	I	I	8	A	8
<i>Tachycineta thalassina</i>	67 N ¹¹	16 N ⁸	23 N ⁸	13 N ⁸	1 ^{8,11}	D	D	8	I	I	8	A	8
<i>Progne subis</i>	60 N ¹¹	20 N ⁸	12 N ⁸	31 S ²¹	2 ^{8,11}	UB	UB	8	I	I	8	A	8
<i>Stelgidopteryx serripennis</i>	61 N ⁸	9 N ⁸	32 N ⁸	8 N ⁸	1 ⁸	UB	UB	8,17	I	I	8	A	8
<i>Riparia riparia riparia (2) (3)</i>	70 N ^{8,11}	25 N ¹¹	12 N ⁸	40 S ²¹	1 ^{8,11}	UB	UB	8,21,22	I	I	8	A	8
<i>Hirundo rustica erythrogaster</i>	66 N ¹¹	20 N ⁸	12 N ⁸	55 S ^{21,22}	1 ^{8,11}	UB	UB	8,21	I	I	8	A	8
<i>Hirundo pyrrhonota</i>	70 N ^{8,11}	16 N ⁸	15 S ⁸	43 S ²¹	1 ⁸	UB	UB	8,21	I	I	8	A	8

REGULIDAE

<i>Regulus calendula</i>	68 N ¹¹	35 N ¹¹	50 N ¹¹	14 N ²²	1 ^{5,11}	WB	WB	11,17,22	I	I	16,28	V	11,16,28
<i>Regulus satrapa</i>	62 N ^{11,17,22}	14 N ^{17,22}	62 N ^{11,17,22}	14 N ^{17,22}	1 ^{5,11}	WB	WB	11,17,22,28	I	I	11,16,28	V	11,16,28

ALAUDIDAE

<i>Eremophila alpestris alpestris</i>	78 N ¹¹	16 N ²²	48 N ¹¹	16 N ²²	2 ¹¹	UB	UB	11,22,28	IS	IS	16,28	G	16,28
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PASSERIDAE

<i>Anthus rubescens</i>	74 N ¹¹	30 N ¹¹	50 N ¹¹	13 N ²²	1 ^{5,11}	UB	UB	22	IS	IS	16,28	G	16,28
<i>Anthus spragueii</i>	56 N ¹¹	45 N ¹¹	35 N ¹¹	17 N ²²	1 ^{5,11}	UB	UB	11,17,22	IS	IS	16,28	G	16,28

FRINGILLIDAE

<i>Carduelis pinus</i>	65 N ^{9,11}	30 N ¹¹	61 N ^{9,11}	24 N ⁹	1 ¹¹	WB	WB	9,22	S	S	9,28	VG	9,16,28
<i>Carduelis tristis</i>	56 N ^{9,11}	33 N ^{11,22}	50 N ^{9,11,22}	18 N ^{9,22}	1 ^{5,11}	MB	MB	9,17	S	S	9,16	VG	9,16
<i>Carduelis psaltria</i>	40 N ⁹	16 N ⁹	35 N ^{9,11}	16 N ⁹	1 ¹¹	MB	MB	9	S	S	9,16	VG	9,16
<i>Carduelis lawrencei</i>	41 N ^{9,11}	30 N ^{9,11}	36 N ^{9,11}	26 N ^{11,22}	1 ¹¹	MB	MB	9,22	S	S	9,16,28	VG	9,16
<i>Calcarius mccownii</i>	52 N ^{7,23}	40 N ⁷	40 N ^{7,23}	25 N ^{7,11}	1 ¹¹	UB	UB	7,23	IS	S	7	G	7,28
<i>Calcarius ornatus</i>	53 N ^{7,11,23}	40 N ^{11,23}	39 N ^{11,23}	18 N ²²	1 ^{11,23}	UB	UB	7,11,23	IS	S	7,28	G	7,28
<i>Carpodacus cassinii</i>	54 N ¹¹	34 N ¹¹	48 N ¹¹	18 N ²²	1 ¹¹	WB	WB	9,11,22	P	P	9,16,28	GV	9,16,28
<i>Calamospiza melanocorys</i>	54 N ¹¹	34 N ¹¹	34 N ¹¹	20 N ⁷	2 ¹¹	UB	UB	7,22	I	IS	7,16	G	7,16
<i>Melospiza melodia</i>	65 N ^{7,11}	27 N ^{7,11}	60 N ^{7,11,22}	23 N ^{7,11}	1 ^{11,23}	MB	MB	7,23	IS	S	7,16,28	G	7,16,28
<i>Melospiza lincolni</i>	67 N ¹¹	35 N ¹¹	50 N ¹¹	11 N ⁷	1 ¹¹	MB	MB	7	IS	S	7,16	G	7,16
<i>Melospiza georgiana</i>	68 N ^{7,11}	37 N ⁷	40 N ⁷	25 N ⁷	1 ¹¹	MB	MB	7	IS	IS	7,16	G	7,16

<i>Zonotrichia albicollis</i>	65 N ^{7,11}	50 N ^{11,23}	40 N ^{7,23}	23 N ^{11,23}	1 ^{11,23}	WB	WB	7,22,23	IS	IS	7,16,28	G	7,16,28
<i>Zonotrichia leucophrys</i>	70 N ^{7,11}	36 N ¹¹	61 N ¹¹	20 N ⁷	1 ¹¹	MB	MB	7	G	S	7,16	G	7,16,28
<i>Passerculus sandwichensis sandwichensis</i>	70 N ^{7,11}	35 N ^{7,11}	49 N ⁷	14 N ⁷	1 ¹¹	UB	UB	7	IS	S	7,16	G	7,16
<i>Ammodramus caudacutus</i>	63 N ^{7,11}	38 N ⁷	38 N ⁷	25 N ⁷	1 ²³	UB	UB	7,22,23	I	IS	7,16,28	G	7,16,28
<i>Ammodramus bairdii</i>	54 N ^{7,11}	45 N ^{7,11}	33 N ^{7,11}	25 N ^{7,11}	1 ^{11,23}	UB	UB	7,23	I	S	7,16,28	G	7,16,28
<i>Ammodramus savannarum</i>	50 N ^{7,11}	30 N ^{7,11}	38 N ^{7,11}	13 N ⁷	1 ¹¹	UB	UB	7	IS	IS	7,16	G	7
<i>Spizella passerina</i>	70 N ¹¹	29 N ^{7,11}	40 N ^{7,11}	16 N ⁷	1 ¹¹	MB	MB	7	IS	S	7,16	G	7
<i>Spizella pallida</i>	64 N ¹¹	44 N ¹¹	30 N ^{7,11}	16 N ⁷	1 ¹¹	MB	MB	7	IS	S	7,16	G	7
<i>Spizella breweri</i>	63 N ¹¹	35 N ¹¹	35 N ^{7,11}	18 N ⁷	1 ¹¹	MB	UB	7	IS	S	7,16	G	7
<i>Spizella pusilla</i>	50 N ^{7,11}	31 N ^{7,11}	42 N ^{7,11}	23 N ^{7,11}	1 ¹¹	MB	MB	7	IS	S	7,16	VG	7,16
<i>Spizella atrogularis</i>	40 N ^{7,11}	30 N ^{7,11}	33 N ^{7,11}	22 N ^{7,11}	1 ¹¹	MB	MB	7	IS	IS	7,16	VG	7,16
<i>Poocetes gramineus</i>	63 N ^{7,11}	33 N ⁷	38 N ^{7,11}	16 N ⁷	1 ¹¹	UB	UB	7	IS	S	7	G	7
<i>Chondestes grammacus</i>	53 N ¹¹	30 N ¹¹	34 N ¹¹	11 N ⁷	1 ¹¹	MB	MB	7	IS	S	7	G	7
<i>Amphispiza bilineata</i>	46 N ⁷	24 N ⁷	34 N ⁷	24 N ⁷	1 ^{11,23}	MB	MB	7,23	IS	IS	7,16,28	G	7,16,28
<i>Amphispiza belli nevadensis</i>	48 N ^{11,23}	34 N ²³	44 N ²³	25 N ^{11,23}	1 ¹¹	MB	UB	7,23	IS	IS	7,16,28	G	7,16,28
<i>Aimophila botterii botterii</i>	34 N ⁷	10 N ⁷	28 N ⁷	10 N ⁷	1 ^{11,23}	MB	MB	7	IS	IS	7	G	7
<i>Aimophila cassinii</i>	42 N ^{11,23}	28 N ^{11,23}	33 N ^{11,23}	21 N ^{7,23}	1 ^{11,23}	MB	MB	7,23	IS	IS	7,28	G	7,28
<i>Pipilo chlorurus</i>	49 N ⁷	34 N ⁷	36 N ²³	20 N ^{7,23}	1 ^{11,23}	MB	MB	7	IS	IS	7	G	7
<i>Pipilo erythrophthalmus erythrophthalmus</i>	52 N ^{7,11}	28 N ⁷	42 N ^{7,11}	25 N ⁷	2 ^{5,11}	MB	MB	7,11,22	IS	IS	7,28	G	7,28
<i>Pipilo erythrophthalmus maculatus</i>	53 N ¹¹	30 N ^{7,11}	52 N ^{7,11}	23 N ⁷	2 ^{5,11}	MB	MB	7,11,22	IS	IS	7,28	G	7,28
<i>Vermivora bachmanii</i>	38 N ¹⁷	35 N ¹⁷	23 N ¹⁸	20 N ¹⁸	1 ¹¹	WB	WB	20,22	I	I	20	V	20
<i>Vermivora pinus</i>	45 N ^{11,20}	33 N ^{11,20}	22 N ²⁰	7 N ²⁰	1 ¹¹	MB	WB	20	I	I	20	V	20
<i>Vermivora chrysoptera</i>	53 N ¹¹	34 N ¹¹	18 N ²⁰	5 N ²⁰	1 ^{11,20}	MB	WB	20	I	I	20	V	20
<i>Vermivora peregrina</i>	70 N ¹¹	45 N ^{11,20}	18 N ²⁰	0 ^{20,21}	1 ^{11,20}	WB	WB	20	I	IF	20	V	20
<i>Vermivora celata</i>	70 N ¹¹	32 N ¹¹	40 N ¹¹	14 N ²⁰	1 ^{11,20}	MB	MB	20	I	IF	20	V	20
<i>Vermivora ruficapilla</i>	51 N ^{11,20}	34 N ^{11,20}	35 N ²⁰	14 N ²⁰	1 ^{11,20}	WB	MB	20,22	I	IF	20	V	20
<i>Vermivora virginiae</i>	44 N ¹¹	31 N ¹¹	22 N ²⁰	18 N ²⁰	1 ^{11,20}	MB	MB	20,22	I	IF	20	V	16,20
<i>Vermivora luciae</i>	36 N ¹¹	29 N ¹¹	28 N ²⁰	17 N ²⁰	1 ^{11,20}	MB	MB	20,22	I	I	20	V	20
<i>Parula americana</i>	49 N ¹¹	39 N ¹¹	38 N ²⁰	11 N ²⁰	1 ^{11,20}	WB	WB	20,22	I	I	20	V	20
<i>Dendroica petechia aestiva</i>	70 N ^{11,20}	20 N ²⁰	20 N ²⁰	12 S ^{20,21}	1 ^{11,20}	MB	MB	20	I	I	20	V	20
<i>Dendroica pensylvanica</i>	56 N ¹¹	35 N ¹¹	23 N ^{18,20}	8 N ²⁰	1 ^{11,20}	WB	WB	20,22	I	I	20	V	20
<i>Dendroica magnolia</i>	66 N ¹¹	35 N ¹¹	27 N ²⁰	10 N ²⁰	1 ^{11,20}	WB	WB	20	I	I	20	V	20

<i>Dendroica tigrina</i>	65 N ¹¹	45 N ¹¹	27 N ²⁰	10 N ²⁰	1 11,20	WB WB	20,22		IF	20	V	20
<i>Dendroica caerulescens</i>	50 N ^{11,20}	35 N ¹¹	27 N ²⁰	18 N ²⁰	1 11,20	WB WB	20,22		IF	20	V	16,20
<i>Dendroica coronata coronata</i>	70 N ¹¹	40 N ¹¹	48 N ¹¹	8 N ²⁰	1 11,20	WB WB	20,22		F	20	VG	16,20
<i>Dendroica coronata auduboni</i>	56 N ¹¹	23 N ^{11,20}	50 N ^{11,20}	8 N ²⁰	1 11,20	WB WB	20		IF	20	VG	16,20
<i>Dendroica nigrescens</i>	54 N ¹¹	30 N ¹¹	26 N ¹¹	16 N ²⁰	1 11,20	WB MB	20			20	V	20
<i>Dendroica townsendi</i>	65 N ¹¹	45 N ¹¹	47 N ¹¹	10 N ²⁰	1 11,20	WB WB	20			20	V	16,20
<i>Dendroica occidentalis</i>	48 N ¹¹	34 N ¹¹	40 N ²⁰	11 N ²⁰	1 11,20	WB WB	20			20	V	16,20
<i>Dendroica virens</i>	60 N ¹¹	32 N ¹¹	28 N ¹¹	5 N ²¹	1 11,20	WB WB	20,21		IF	20	V	20
<i>Dendroica chrysoparia</i>	33 N ¹¹	28 N ¹¹	17 N ²⁰	11 N ²⁰	1 11,20	WB WB	20			20	V	20
<i>Dendroica fusca</i>	55 N ¹¹	34 N ¹¹	11 N ²⁰	18 S ^{20,21}	1 20	WB WB	17,20			20	V	16,20
<i>Dendroica dominica</i>	43 N ¹¹	28 N ¹¹	33 N ²⁰	10 N ²⁰	1 11,20	WB D	20			20	V	20
<i>Dendroica graciae</i>	40 N ¹¹	23 N ²⁰	26 N ²⁰	18 N ²⁰	1 11,20	WB WB	20			20	SV	20
<i>Dendroica pinus</i>	52 N ¹¹	33 N ^{11,20}	40 N ^{11,20}	25 N ²⁰	1 11,20	WB WB	20			20	V	16,20
<i>Dendroica kirtlandii</i>	49 N ²⁰	43 N ²⁰	27 N ²⁰	22 N ²⁰	1 11,20	WB MB	20			20	V	20
<i>Dendroica discolor</i>	46 N ¹¹	30 N ¹¹	27 N ²⁰	16 N ²⁰	1 11,20	MB MB	20		IF	20	V	16,20
<i>Dendroica palmarum</i>	68 N ¹¹	45 N ¹¹	38 N ¹¹	18 N ²⁰	1 11,20	WB UB	20,22			20	VG	16,20
<i>Dendroica castanea</i>	65 N ¹¹	44 N ¹¹	10 N ²⁰	8 S ²¹	1 11,20	WB WB	20,21		IF	20	V	20
<i>Dendroica striata</i>	70 N ¹¹	43 N ¹¹	9 N ²⁰	16 S ^{20,21}	1 11,20	WB WB	20,21			20	V	20
<i>Dendroica cerulea</i>	49 N ¹¹	32 N ¹¹	12 N ²⁰	17 S ^{20,21}	1 11,20	WB WB	20,21			20	SV	16,20
<i>Mniotilta varia</i>	66 N ¹¹	30 N ¹¹	30 N ¹¹	10 S ²¹	1 11,20	WB WB	20			20	V	20
<i>Setophaga ruticilla</i>	65 N ¹¹	31 N ¹¹	27 N ¹¹	16 S ²¹	1 11,20	WB WB	20,21			20	V	16,20
<i>Protonotaria citrea</i>	45 N ¹¹	26 N ¹¹	27 N ²⁰	0 ^{20,21}	1 11,20	WB WB	20			20	V	16,20
<i>Helmitheros vermivorus</i>	43 N ¹¹	30 N ¹¹	27 N ²⁰	7 N ²⁰	1 20	WB WB	20			20	V	20
<i>Limnothlypis swainsonii</i>	39 N ¹¹	30 N ¹¹	27 N ²⁰	17 N ²⁰	1 11,20	WB WB	20			20	G	16,20
<i>Seiurus aurocapillus</i>	63 N ¹¹	34 N ¹¹	30 N ^{11,20}	10 N ^{20,21}	1 11,20	WB WB	20,21			20	G	16,20
<i>Seiurus noveboracensis</i>	70 N ¹¹	38 N ¹¹	27 N ^{11,20}	3 S ^{20,21}	1 11,20	WB WB	20,21,22			20,28	G	16,20,28
<i>Seiurus motacilla</i>	47 N ¹¹	31 N ¹¹	27 N ²⁰	3 N ²¹	1 11,20	WB WB	20,22			20,28	G	16,20,28
<i>Oporornis formosus</i>	46 N ¹¹	31 N ¹¹	22 N ²⁰	8 N ²⁰	1 11,20	WB WB	20			20	G	16,20
<i>Oporornis agilis</i>	60 N ¹¹	45 N ¹¹	12 N ²⁰	17 S ²¹	1 11,20	WB WB	20,21			20	VG	16,20
<i>Oporornis philadelphia</i>	62 N ¹¹	37 N ¹¹	14 N ²⁰	3 S ²¹	1 11,20	WB MB	20			20	VG	16,20
<i>Oporornis tolmiei</i>	62 N ¹¹	32 N ¹¹	26 N ²⁰	7 N ²⁰	1 11,20	WB MB	20			20	V	16,20
<i>Geothlypis trichas trichas</i>	67 N ¹¹	30 N ^{11,20}	40 N ^{11,20}	3 N ^{20,21}	1 11,20	MB MB	20,21			20	V	16,20

<i>Wilsonia citrina</i>	45 N ¹¹	30 N ¹¹	27 N ²⁰	8 N ²⁰	1 11,20	WB WB 20	I I 20	V 20
<i>Wilsonia pusilla</i>	70 N ¹¹	37 N ¹¹	30 N ^{11,20}	8 N ²⁰	1 11,20	WB WB 20	I I 20	SV 16,20
<i>Wilsonia canadensis</i>	61 N ¹¹	35 N ¹¹	12 N ²⁰	6 N ²¹	1 11,20	WB WB 20	I I 20	SV 16,20
<i>Cardellina rubrifrons</i>	36 N ¹¹	22 N ²⁰	24 N ²⁰	13 N ²⁰	1 11,20	WB WB 20	I I 20	V 16,20
<i>Myioborus pictus</i>	36 N ¹¹	22 N ²⁰	28 N ²⁰	13 N ²⁰	1 11,20	WB WB 20	I I 20	V 16,20
<i>Icteria virens</i>	54 N ¹¹	20 N ²⁰	20 N ²⁰	8 N ²⁰	1 11,20	WB WB 20	IF IF 20	V 16,20
<i>Piranga flava hepatica</i>	37 N ¹¹	12 N ^{17,22}	32 N ¹¹	12 N ^{17,22}	2 5,11	WB WB 11,17,22	IF IF 16,28	V 16,28
<i>Piranga rubra</i>	40 N ¹¹	25 N ²²	24 N ²²	5 N ²¹	1 5,11	WB WB 11,17,21,22	I IF 16,28	V 16,28
<i>Piranga olivacea</i>	51 N ¹¹	33 N ¹¹	10 N ²²	4 N ²¹	1 5,11	WB WB 21,22	I IF 16,28	V 16,28
<i>Piranga ludoviciana</i>	62 N ¹¹	30 N ¹¹	27 N ¹¹	8 N ²²	1 5,11	WB WB 11,22	IF IF 16,28	V 16,28
<i>Spiza americana</i>	51 N ¹¹	30 N ¹¹	20 N ²²	1 N ²¹	1 5,11	UB UB 11,17,22	I S 16,28	G 16,28
<i>Pheucticus ludovicianus</i>	64 N ¹¹	33 N ¹¹	27 N ^{18,22}	8 N ²¹	2 5,11	WB WB 21,22	IS IS 16,28	V 16,28
<i>Pheucticus melanocephalus</i>	55 N ¹¹	17 N ²²	29 N ¹¹	17 N ²²	2 5	WB WB 17,22	IS IS 16,28	V 16,28
<i>Guiraca caerulea</i>	45 N ¹¹	20 N ²²	26 N ¹¹	7 N ²²	1 5,11	MB MB 22	IS IS 16,28	VG 16,28
<i>Passerina amoena</i>	53 N ¹¹	30 N ¹¹	32 N ¹¹	17 N ²²	1 5,11	MB MB 11,17,22,28	IS IS 16,28	VG 16,28
<i>Passerina cyanea</i>	50 N ¹¹	30 N ¹¹	27 N ^{18,22}	7 N ²²	1 5,11	MB MB 11,17,22,28	IS IS 16,28	V 16,28
<i>Passerina versicolor</i>	33 N ¹¹	15 N ²²	27 N ^{11,22}	15 N ²²	1 5,11	MB MB 17,22	IS IS 16,28	V 16,28
<i>Passerina ciris pallidior</i>	39 N ^{11,17}	26 N ^{11,17}	25 N ^{11,22}	7 N ²²	1 11	MB MB 17,22	IS IS 16,28	G 16,28
<i>Passerina ciris ciris</i>	36 N ^{11,17}	28 N ^{11,17}	28 N ^{11,17}	17 N ¹⁷	1 5,11	MB MB 17,22	IS IS 16,28	G 16,28
<i>Icterus galbula bullockii</i>	52 N ¹¹	25 N ²²	35 N ^{11,22}	14 N ²²	2 5,11	WB WB 17,22	IF IF 16,28	V 16,28
<i>Icterus galbula galbula</i>	67 N ¹¹	33 N ¹¹	36 N ¹¹	1 N ²¹	2 5,11	WB WB 17,22	IF IF 16,28	V 16,28
<i>Icterus cucullatus</i>	43 N ¹¹	16 N ²²	27 N ¹¹	16 N ²²	1 5,11	WB WB 17,22,28	IF IF 16,28	V 16,28
<i>Icterus spurius spurius</i>	50 N ¹¹	18 N ²²	25 N ²²	2 N ^{21,22}	1 5,11	MB MB 22,28	IF IF 16,28	V 16,28
<i>Icterus parisorum</i>	44 N ¹¹	17 N ²²	30 N ¹¹	17 N ²²	2 5,11	MB MB 11,22,28,57	IF IF 16,28	V 16,28
<i>Agelaius phoeniceus</i>	68 N ¹¹	10 N ²²	52 N ^{11,22}	10 N ²²	2 5,11	MB UB 17,22	IS IS 16,28	G 16,28
<i>Sturnella magna</i>	50 N ¹¹	25 N ²²	43 N ¹¹	25 N ²²	2 5,11	UB UB 22	IS IS 16,28	G 16,28
<i>Sturnella neglecta</i>	56 N ¹¹	20 N ²²	50 N ¹¹	18 N ²²	2 5,11	UB UB 17,22	IS IS 16,28	G 16,28
<i>Euphagus cyanocephalus</i>	62 N ¹¹	30 N ^{11,22}	52 N ¹¹	16 N ²²	2 5,11	D D 17,22,28	IS IS 16,28	G 16,28
<i>Molothrus aeneus aeneus</i>	35 N ¹¹	8 N ²²	26 N ¹¹	8 N ²²	2 5,11	MB MB 22,28	IS IS 16,28	G 16,28
<i>Molothrus ater</i>	63 N ¹¹	17 N ²²	45 N ^{11,22}	16 N ²²	2 5,11	WB D 22	IS S 16,28	G 16,28
<i>Dolichonyx oryzivorus</i>	55 N ¹¹	38 N ¹¹	27 N ^{18,22}	35 S ²¹	2 5,11	UB UB 17,22	IS IS 16,28	G 16,28

WP-A FLYWAY

Scientific name	Distribution				Mean body mass	Habitat		Diet		Foraging mode
	BR range		NBR range			BR	NBR	BR	NBR	
	N limit	S limit	N limit	S limit						
PHASIANIDAE										
<i>Coturnix coturnix coturnix (1)</i>	61 N ²	28 N ⁴	44 N ^{1,2}	4 S ⁴	3 ^{1,5}	UB	UB ^{1,2,4,55}	IS	IS ^{1,2,4,55}	G ^{2,4}
PICIDAE										
<i>Jynx torquilla (1)</i>	70 N ²	38 N ^{2,25}	15 N ^{4,25}	0 ^{4,25}	2 ^{2,25}	WB	MB ^{2,25}	I	I ^{2,25}	G ^{2,25}
UPUPIDAE										
<i>Upupa epops (1)</i>	60 N ^{1,2}	28 N ^{1,2}	22 N ¹	4 N ^{1,2}	2 ^{2,5}	MB	MB ^{1,2,4}	I	I ^{1,2,4}	G ^{1,2}
CORACIIDAE										
<i>Coracias garrulus</i>	60 N ^{1,2}	30 N ^{1,2,4}	15 N ^{1,3,4}	35 S ^{1,3,4}	3 ^{3,5}	D	MB ^{1,3,4}	I	I ^{1,3}	P ^{1,3}
MEROPIDAE										
<i>Merops persicus</i>	47 N ¹	23 N ¹	20 N ⁴	29 S ^{4,34}	2 ⁴	UB	MB ^{1,3,4}	I	I ⁴	S ^{3,4}
<i>Merops apiaster</i>	58 N ^{1,2,3}	29 N ^{1,2,3,4}	11 N ^{3,4}	27 S ^{3,34}	2 ^{3,4,5}	MB	MB ^{1,2,3}	I	I ^{1,3}	S ^{1,3}
CUCULIDAE										
<i>Clamator glandarius</i>	45 N ¹	30 N ¹	35 N ¹	23 N ¹	3 ^{1,4}	MB	MB ^{1,4}	I	I ^{1,2,4}	VG ^{2,4}
<i>Cuculus canorus canorus (1)</i>	71 N ^{1,2}	32 N ^{1,2}	15 N ^{1,2,4}	35 S ^{1,2,4}	3 ^{1,4}	D	UB ^{1,2,4}	I	I ¹	VG ²
APODIDAE										
<i>Tachymarphs melba</i>	48 N ^{2,6}	27 N ^{1,6}	15 N ⁶	0 ⁶	3 ^{1,4,6}	D	D ^{1,4,6}	I	I ^{1,4}	A ^{1,4}
<i>Apus apus</i>	70 N ^{1,2,6}	30 N ^{4,6}	5 N ^{4,6}	33 S ^{4,6}	2 ⁴	D	D ^{1,2,4,6}	I	I ^{2,4}	A ²
<i>Apus pallidus</i>	48 N ^{1,2}	16 N ^{1,6}	15 N ^{1,6}	5 N ⁶	2 ¹	D	D ^{1,2,4,6}	I	I ^{1,2}	A ^{2,6}
STRIGIDAE										
<i>Otus scops scops</i>	58 N ^{1,2,19}	30 N ^{1,2,19}	20 N ^{1,2}	0 ^{1,2}	2 ^{2,5}	MB	MB ^{1,2,19}	I	I ^{1,19}	P ^{1,2,19}
<i>Asio flammeus (1) (2)</i>	71 N ^{1,2,19}	39 N ^{1,2,19}	58 N ^{1,2}	3 S ⁴	3 ^{2,5}	UB	UB ^{1,2,4,19}	V	V ^{1,2,19}	P ^{1,2,19}
CAPRIMULGIDAE										
<i>Caprimulgus ruficollis</i>	43 N ^{1,2}	30 N ^{1,2}	20 N ¹	10 N ¹	2 ¹	D	D ¹	I	I ^{1,2,26}	A ^{1,2,4}
<i>Caprimulgus europaeus</i>	64 N ^{1,2,26}	30 N ^{2,26}	18 N ^{1,26}	35 S ^{1,2,26}	2 ^{5,26}	D	MB ^{1,4,26}	I	I ^{1,26}	A ^{1,26}
<i>Caprimulgus aegyptius</i>	47 N ^{1,26}	25 N ^{1,26}	23 N ²⁶	10 N ^{1,26}	2 ^{1,4}	UB	UB ^{1,4,26}	I	I ^{1,26}	A ^{1,26}
COLUMBIDAE										
<i>Streptopelia turtur</i>	64 N ^{1,2}	21 N ⁴	20 N ⁴	5 N ^{1,4}	3 ^{1,2}	D	MB ^{1,2,4}	S	S ^{1,2,4}	G ^{1,2,4}

GRUIDAE*Grus virgo* (1)50 N^{1,2} 43 N^{1,2} 18 N^{1,2,4} 9 N⁴ 3¹ UB UB 1,2,4,53 G G 1,2,4,53 G 1,2,53*Grus grus* (1)70 N^{1,2} 37 N² 42 N^{2,53} 9 N⁴ 3^{1,4,5} UB UB 1,2,4,53 G G 1,2,4,53 G 2,4,53**RALLIDAE***Crex crex*68 N^{2,44} 31 N⁴⁴ 3 S^{4,44} 34 S^{1,4,44} 3⁴⁴ UB UB 1,4,44 I I 1,4,44 G 1,44**BURHINIDAE***Burhinus oedicephalus*54 N² 23 N² 38 N² 2 N⁴ 3⁴ UB UB 2,4 VI VI 2,4 G 1,4,54**CHARADRIIDAE***Charadrius asiaticus*51 N^{1,2,54} 35 N^{1,2,54} 18 N^{1,4} 35 S^{1,4,54} 2^{1,4,5} UB UB 1,2,4,54 I I 1,2,4 G 2,4*Vanellus vanellus* (1)70 N^{1,2} 36 N² 58 N² 25 N⁴ 3^{1,5} UB UB 1,2,4,54 I I 1,2,4 G 2,4*Vanellus gregarius* (1)56 N^{2,54} 47 N^{1,2,54} 35 N^{1,2} 10 N⁴ 3^{1,5} UB UB 1,2,4,54 I I 1,2,4 G 2,4**GLAREOLIDAE***Glareola pratincola*48 N² 25 N² 18 N^{2,4} 5 N^{2,4} 2² UB UB 2,4 I I 2,4 A 2,4*Glareola nordmanni*55 N² 42 N² 17 N⁴ 30 S³⁴ 2^{1,4,5} UB UB 1,2,4,34 I I 1,2,4 A 1,2,4**ACCIPITRIDAE***Pernis apivorus*67 N^{1,2} 38 N^{1,2} 11 N⁴ 34 S⁴ 3^{1,2} WB WB 1,2,4,13 I I 1,2,4,13 GV 1,2,12,13*Milvus migrans migrans* (1)67 N^{1,2} 28 N^{1,2} 36 N^{1,2} 35 S^{1,2} 3^{1,4} D D 1,4,13 VI VI 1,4,13 A,P 1,13*Neophron percnopterus*48 N^{1,2} 28 N^{1,2} 30 N² 14 N² 3^{1,4} UB UB 1,4 VI VI 1,4 P 1*Gyps fulvus*45 N^{1,2} 27 N² 41 N² 14 N^{2,4} 3^{1,4} UB UB 1,2,4 V V 1,4 P 1*Circaetus gallicus gallicus* (1)60 N^{1,2} 28 N^{1,2} 20 N² 10 N^{1,2} 3^{1,5} D D 1,2,13 V V 1,13 A,P 1,2,13*Circus macrourus* (1)56 N^{1,2} 39 N^{1,2} 42 N^{1,2} 35 S⁴ 3^{1,4} UB UB 1,2,4,13 VI VI 1,4,13 A,P 1,2,13*Circus pygargus* (1)61 N^{1,2} 33 N^{1,2} 20 N⁴ 33 S^{1,4} 3^{1,4} UB UB 1,4,13 VI VI 1,4,13 P 1,4,13*Accipiter brevipes*52 N^{1,2} 32 N^{1,2} 18 N⁴ 3 N⁴ 3⁵ MB MB 1,13 VI VI 1,13 P 2,13*Accipiter nisus* (1)70 N^{1,2} 55 N^{1,2} 50 N¹ 4 S⁴ 3² D MB 1,4,13 V V 1,4,13 A,P 1,2,13*Buteo buteo buteo*67 N^{1,2} 45 N² 59 N² 5 N⁴ 3¹² D D 1,4,13 VI VI 1,4,13 P 1,4,12,13*Buteo buteo vulpinus* (1)67 N^{2,12} 42 N¹ 41 N² 35 S^{1,2} 3¹² D D 1,4,13 VI VI 1,4,13 P 1,4,12,13*Buteo rufinus* (1)53 N^{1,2} 42 N^{1,2} 42 N^{1,2} 1 N⁴ 3² D D 1,4,13 V V 1,13 P 1,2,13*Aquila pomarina*60 N^{1,2} 36 N^{1,2} 20 N^{1,2} 30 S⁴ 3^{1,4} WB MB 1,2,4,13 V VI 1,2,4,13 P 1,2,13*Aquila clanga* (1)65 N^{1,2} 45 N² 45 N^{1,2} 0⁴ 3^{1,4} WB UB 1,2,4,12,13 V V 1,13 P 1,13*Aquila nipalensis orientalis*53 N¹ 42 N¹ 35 N¹ 27 S⁴ 3⁴ UB UB 1,12,13 V VI 1,4,13 P 1,12,13*Aquila heliaca* (1)55 N^{1,2} 37 N¹ 36 N¹ 4 S⁴ 3^{1,4} MB UB 1,2,4,13 V V 1,2,13 P 1,2,13*Hieraaetus pennatus* (1)56 N^{1,2} 30 N^{2,4} 17 N^{1,4} 32 S^{1,4} 3^{1,4} MB MB 1,4,13 V V 1,13 P 1,13

FALCONIDAE

<i>Falco naumanni</i>	55 N ^{1,2}	31 N ^{1,2}	26 N ¹	35 S ^{1,2,4}	3 ⁵	UB UB	1,2,4,13	I I	1,4,13	A,P	1,13
<i>Falco tinnunculus</i> (1)	71 N ²	38 N ^{1,2}	59 N ²	25 N ²	3 ¹	UB UB	1,2,4,13	VI VI	1,4,13	P	1,4,13
<i>Falco vespertinus</i>	64 N ^{1,2}	43 N ^{1,2}	14 S ⁴	31 S ⁴	3 ^{1,4}	MB MB	1,2,4,13	VI I	1,4,13	A,P	1,2,13
<i>Falco eleonora</i>	43 N ²	29 N ²	2 N ^{1,4}	26 S ^{1,4}	3 ⁴	MB MB	1,2,4,13	V I	2,4,13	A	2,4,13
<i>Falco concolor</i>	34 N ¹	10 N ^{1,4}	11 S ^{1,4}	30 S ^{1,4}	3 ⁵	UB MB	1,2,13	V VI	1,4,13	A	1,2,13
<i>Falco subbuteo</i> (1)	67 N ^{1,2}	30 N ^{1,2,4}	6 S ⁴	34 S ⁴	3 ⁴	MB MB	2,4,13	VI I	1,4,13	A	1,2,12,13
<i>Falco cherrug</i> (1)	57 N ²	43 N ¹	46 N ^{1,2}	1 S ⁴	3 ⁴	UB UB	1,2,4,13	V V	1,2,12,13	P	1,2,13
<i>Falco peregrinus</i> (1) (2)	75 N ²	53 N ²	55 N ²	34 S ^{3,4}	3 ^{1,5}	UB UB	1,2,13	V V	1,13	A	1,2,13
<i>Falco pelegrinoides</i>	40 N ²	12 N ²	40 N ²	2 N ²	3 ²	UB UB	2,13	V V	2,13	A	2,13

THRESKIORNITHIDAE

<i>Geronticus eremita</i>	37 N ²	36 N ²	19 N ⁴	10 N ⁴	3 ²	UB UB	2,4	I I	1,4	G	2,4
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CICONIIDAE

<i>Ciconia ciconia</i>	60 N ^{1,2}	30 N ^{1,2}	20 N ¹	35 S ^{1,4}	3 ^{1,2}	UB UB	1,2,4,3,4	VI VI	1,2,4	G	1,2,4
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LANIIDAE

<i>Lanius collurio</i>	66 N ^{1,2}	33 N ^{2,10}	2 N ^{4,10}	34 S ^{4,10}	1 ^{4,10}	MB MB	4,10	I I	4,10	P	2,10
<i>Lanius isabellinus phoenicuroides</i>	47 N ¹⁰	29 N ¹⁰	30 N ¹⁰	8 S ⁴	1 ¹⁰	UB MB	4,10	VI VI	4,10	P	4,10
<i>Lanius minor</i>	55 N ^{2,10}	34 N ¹⁰	16 S ^{4,10}	32 S ⁴	2 ^{2,4,5}	UB MB	2,4,10	I I	2,4,10	P	2,4,10
<i>Lanius excubitor meridionalis</i>	50 N ¹⁰	29 N ¹⁰	45 N ^{2,10}	8 N ^{2,4,10}	2 ^{2,10}	MB UB	2,4,10	VI VI	2,4,10	P	2,4,10
<i>Lanius senator</i>	54 N ²	29 N ^{2,10}	20 N ^{4,10}	1 S ⁴	1 ^{4,5,10}	MB MB	2,4,10	I I	2,4,10	P	2,4,10
<i>Lanius nubicus</i>	43 N ^{2,10}	29 N ^{2,10}	23 N ⁴	0 ^{4,10}	1 ^{5,10}	WB MB	2,4,10	I I	2,4,10	P	2,4,10

CORVIDAE

<i>Oriolus oriolus</i> (1)	63 N ²	25 N ^{2,4}	8 N ⁴	35 S ^{2,4}	2 ^{2,5}	MB MB	2,4	I IF	2,4	V	2,4
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MUSCICAPIDAE

<i>Monticola saxatilis</i>	51 N ²	31 N ^{2,4}	24 N ^{2,4,35}	10 S ^{4,35}	2 ³⁵	UB MB	4,35	I I	35	P	2,4,35
<i>Monticola solitarius solitarius</i>	47 N ^{2,35}	30 N ^{4,35}	33 N ^{2,35}	10 N ⁴	2 ⁴	UB D	4,35	I I	4,35	P	2,4,35
<i>Turdus philomelos</i>	70 N ³⁵	35 N ³⁵	46 N ^{2,35}	19 N ^{2,35}	2 ³⁵	WB MB	2,35	IF IF	35	G	2,4,35
<i>Muscicapa striata</i>	71 N ²	30 N ^{2,4}	15 N ⁴	35 S ^{2,4}	1 ^{4,5}	WB MB	2,4	I I	2,4	S	2,4
<i>Ficedula hypoleuca</i>	71 N ²	31 N ^{2,4}	14 N ⁴	5 S ⁴	1 ^{4,5}	WB WB	2,4	I I	2,4	VS	2,4
<i>Ficedula albicollis</i>	58 N ²	39 N ²	4 S ⁴	20 S ^{2,4}	1 ^{2,4,5}	WB MB	2,4	I I	2,4	VS	2,4
<i>Ficedula semitorquata</i>	45 N ²	37 N ²	6 N ^{2,4}	10 S ^{2,4}	1 ⁴	WB MB	2,4	I I	2,4	S	2,4
<i>Luscinia luscinia</i>	65 N ²	40 N ²	9 N ⁴	26 S ⁴	1 ^{2,4,5}	MB MB	2,4	I I	2,4	G	2,4

<i>Luscinia megarhynchos</i>	55 N ²	30 N ^{2,4}	20 N ^{2,4}	7 S ⁴	1 2,5	MB MB ^{2,4}	I I ^{2,4}	G ^{2,4}
<i>Luscinia svecica</i> (1)	71 N ²	38 N ²	44 N ²	7 N ⁴	1 2	D MB ^{2,4,17}	I I ^{2,4}	VG ^{2,4}
<i>Irania gutturalis</i>	43 N ²	28 N ²	1 N ⁴	6 S ⁴	1 2,5	MB MB ^{2,4}	I I ^{2,4}	VG ^{2,4}
<i>Cercotrichas galactotes galactotes</i>	41 N ^{2,17}	23 N ^{2,17}	19 N ^{2,4}	10 N ^{2,4}	1 4	MB MB ^{2,4}	I I ^{2,4}	VG ^{2,4}
<i>Cercotrichas galactotes familiaris</i>	47 N ^{2,17}	25 N ^{2,17}	19 N ^{2,4}	5 S ^{2,4}	1 2	MB MB ^{2,4}	I I ^{2,4}	VG ^{2,4}
<i>Phoenicurus ochruros</i> (1)	61 N ²	29 N ²	54 N ²	9 N ⁴	1 2,5	UB MB ^{2,4,33}	I I ^{2,4}	PG ^{2,4}
<i>Phoenicurus phoenicurus</i>	71 N ²	29 N ²	20 N ⁴	2 S ⁴	1 4,5	WB MB ^{2,4}	I I ^{2,4}	PSV ^{2,4}
<i>Saxicola rubetra</i>	70 N ²	33 N ²	36 N ²	16 S ⁴	1 2,5	UB UB ^{2,4}	I I ^{2,4}	PS ^{2,4}
<i>Saxicola torquata torquata</i>	58 N ^{2,17}	29 N ^{2,4}	54 N ^{2,17}	27 N ^{2,4}	1 5	UB MB ^{2,4}	I I ^{2,4}	P ^{2,4}
<i>Saxicola torquata maura</i> (1)	67 N ^{2,17}	34 N ^{2,17}	39 N ²	8 N ^{2,4,17}	1 5	UB MB ²	I I ²	P ²
<i>Oenanthe oenanthe oenanthe</i>	73 N ²	33 N ²	35 N ²	18 S ⁴	1 5	UB UB ^{2,4}	I I ^{2,4}	PG ^{2,4}
<i>Oenanthe hispanica</i>	46 N ²	29 N ²	20 N ⁴	7 N ⁴	1 2,5	MB MB ^{2,4}	I I ^{2,4}	PG ^{2,4}
<i>Oenanthe pleschanka</i>	55 N ²	31 N ²	23 N ⁴	4 S ⁴	1 5	UB MB ^{2,4}	I I ^{2,4}	P ^{2,4}
<i>Oenanthe cyprica</i>	36 N ²	34 N ²	23 N ⁴	4 S ⁴	1 4	MB MB ^{2,4}	I I ^{2,4}	P ^{2,4}
<i>Oenanthe xanthopyrma xanthopyrma</i>	42 N ^{2,4}	36 N ^{2,4}	31 N ^{2,4}	10 N ⁴	1 5	UB UB ^{2,4,17}	I I ^{2,4}	PG ⁴
<i>Oenanthe xanthopyrma chrysopygla</i> (1)	42 N ^{2,17}	27 N ^{2,17}	29 N ²	10 N ^{2,4}	1 5	UB UB ^{2,4,17}	I I ^{2,4}	G ^{2,4}
<i>Oenanthe deserti</i> (1)	50 N ²	30 N ⁴	35 N ²	0 ⁴	1 5	UB UB ^{2,4}	I I ²	PG ^{2,4}
<i>Oenanthe isabellina</i> (1)	52 N ²	27 N ²	36 N ²	10 S ⁴	1 2,5	UB UB ^{2,4}	I I ^{2,4}	PG ^{2,4}
STURNIDAE								
<i>Sternus vulgaris</i> (1)	71 N ^{2,41}	43 N ^{2,41}	58 N ^{2,41}	22 N ⁴	2 5,41	UB UB ⁴¹	G G ^{2,41}	G ^{2,41}
HIRUNDINIDAE								
<i>Riparia riparia riparia</i> (1) (2)	71 N ²	24 N ²	20 N ^{2,8}	30 S ^{2,8}	1 8	D D ^{4,8}	I I ^{2,4,8}	A ^{2,8}
<i>Hirundo rupestris</i> (1)	48 N ²	36 N ²	47 N ²	5 N ⁴	1 8	UB UB ^{2,4,8}	I I ^{4,8}	A ⁸
<i>Hirundo rustica rustica</i> (1)	70 N ^{2,8}	30 N ^{2,8}	12 N ^{2,4}	35 S ^{2,4,8}	1 4,8	UB D ^{2,4,8}	I I ^{2,8}	A ^{2,8}
<i>Hirundo daurica rufula</i>	46 N ^{2,4}	29 N ^{2,4}	36 N ^{2,4}	10 N ^{2,4}	1 4	UB MB ^{2,4}	I I ^{2,4}	A ^{2,4}
<i>Delichon urbica</i> (1)	70 N ^{2,8}	29 N ^{2,8}	20 N ^{4,8}	35 S ^{4,8}	1 8	D D ^{2,4,8}	I I ^{2,4,8}	A ^{2,8}
SYLVIIDAE								
<i>Locustella naevia</i> (1)	66 N ^{2,42}	40 N ^{2,42}	36 N ^{2,4,42}	7 N ^{4,42}	1 2,4	MB MB ^{2,42}	I I ²	VG ^{2,4}
<i>Locustella fluviatilis</i>	64 N ²	44 N ^{2,42}	0 ^{4,42}	26 S ^{4,42}	1 5,42	D MB ^{2,4,42}	I I ^{2,4}	VG ^{2,4}
<i>Locustella luscinioides</i>	59 N ^{2,42}	32 N ^{2,42}	18 N ⁴	5 N ⁴	1 2,42	MB MB ^{2,4,42}	I I ^{2,4}	V ^{2,4}
<i>Acrocephalus scirpaceus</i>	65 N ²	28 N ^{2,42}	28 N ⁴	20 S ⁴	1 2,5	MB MB ^{2,4,42}	I I ^{2,4}	V ^{2,4,42}
<i>Acrocephalus palustris</i>	64 N ²	37 N ²	1 N ⁴	35 S ⁴	1 2,5,42	D MB ^{2,4,42}	I I ^{2,4}	V ^{2,4,42}

<i>Hippolias pallida</i>	48 N ^{2,42}	20 N ^{2,42}	20 N ^{4,42}	7 S ⁴	1 ^{2,42}	D MB ^{2,4,42}	I I ^{2,4}	V ^{2,4}	
<i>Hippolias languida</i>	46 N ^{2,42}	27 N ^{2,42}	5 N ⁴	6 S ⁴	1 ⁴²	MB MB ^{2,4,42}	I I ^{2,4}	V ^{2,4}	
<i>Hippolias olivetorum</i>	44 N ^{2,42}	31 N ⁴²	1 N ⁴	29 S ⁴	1 ⁴²	MB MB ^{2,4,42}	I I ²	V ^{2,4}	
<i>Hippolias polyglotta</i>	51 N ²	31 N ^{2,4,42}	14 N ⁴	4 N ⁴	1 ⁴²	WB MB ^{2,4,42}	I I ^{2,4}	V ^{2,4}	
<i>Hippolais icterina</i>	70 N ²	37 N ^{2,42}	0 ⁴	32 S ^{4,42}	1 ^{2,42}	WB MB ^{2,4,42}	I I ^{2,4}	VS ^{2,4}	
<i>Phylloscopus trochilus</i>	72 N ^{2,42}	43 N ^{2,42}	12 N ^{4,42}	35 S ^{2,4,42}	1 ^{2,5,42}	D D ^{2,4,42}	I I ^{2,4,42}	V ^{2,4,42}	
<i>Phylloscopus collybita collybita</i>	70 N ^{2,17,42}	37 N ^{2,17,42}	54 N ^{2,42}	1 S ⁴	1 ²	WB D ^{2,4,42}	I I ^{2,4,42}	V ^{2,4,42}	
<i>Phylloscopus brehmii</i>	44 N ^{4,42}	35 N ^{4,42}	42 N ^{2,42}	1 S ^{2,4,42}	1 ²	WB D ^{2,4,42}	I I ^{2,4,42}	V ^{2,4,42}	
<i>Phylloscopus orientalis</i>	44 N ^{2,42}	33 N ^{2,42}	16 N ^{4,42}	10 N ⁴	1 ²	MB MB ^{2,4,42}	I I ^{2,4,42}	V ^{2,4,42}	
<i>Phylloscopus bonelli</i>	50 N ^{2,42}	31 N ^{2,4,42}	19 N ^{4,42}	10 N ^{4,42}	1 ²	MB MB ^{2,4,42}	I I ^{2,4,42}	V ^{2,4,42}	
<i>Phylloscopus sibilatrix</i>	70 N ⁴²	39 N ^{2,42}	10 N ^{4,42}	5 S ^{4,42}	1 ^{2,4,5}	WB WB ^{2,4,42}	I I ^{2,4,42}	V ^{2,4,42}	
<i>Sylvia atricapilla</i>	70 N ^{2,42}	35 N ⁴²	58 N ^{2,42}	14 S ⁴	1 ⁴	WB D ^{2,4,42,43}	I IF ^{2,4,43}	V ^{2,4,43}	
<i>Sylvia borin</i>	70 N ^{2,42}	37 N ^{2,42}	14 N ^{4,42}	32 S ^{4,42}	1 ^{2,4,5}	MB MB ^{2,4,42,43}	I IF ^{2,4,42,43}	V ^{2,4,43}	
<i>Sylvia communis</i>	69 N ^{2,42}	37 N ^{2,4,42}	18 N ⁴	27 S ⁴	1 ^{4,42}	MB MB ^{2,4,42,43}	I IF ^{2,4,43}	V ^{2,4,43}	
<i>Sylvia curruca (1)</i>	67 N ^{2,42}	32 N ^{2,42}	31 N ^{2,42}	6 N ⁴	1 ^{2,42}	MB MB ^{2,4,42,43}	I IF ^{2,4,33,43}	V ^{2,43}	
<i>Sylvia Nana (1)</i>	49 N ^{2,42}	32 N ⁴²	35 N ^{2,42}	9 N ^{2,4,42}	1 ^{2,4,42}	UB MB ^{2,4,42,43}	I I ^{2,4,42,43}	VG ^{2,43}	
<i>Sylvia nisoria</i>	60 N ²	39 N ^{2,42}	6 N ⁴	6 S ⁴	1 ^{2,42}	MB MB ^{2,4,42,43}	I IF ^{2,4,43}	V ^{2,4,43}	
<i>Sylvia hortensis</i>	46 N ^{2,42}	28 N ^{2,4}	28 N ^{2,42}	10 N ^{4,42}	1 ^{2,4,42}	MB MB ^{2,4,42,43}	IF IF ^{2,4,43}	V ^{2,4,43}	
<i>Sylvia rueppelli</i>	41 N ^{2,42}	35 N ^{2,42}	23 N ^{2,42}	10 N ^{2,42}	1 ^{4,42}	MB MB ^{2,4,42,43}	I I ^{2,4,43}	V ^{2,4,43}	
<i>Sylvia melanocephala</i>	46 N ^{2,42}	27 N ^{2,4,42}	46 N ^{2,42}	17 N ⁴	1 ^{4,42}	MB MB ^{2,4,42,43}	I IF ^{2,4,43}	V ^{2,4,43}	
<i>Sylvia cantillans</i>	46 N ^{2,42}	27 N ^{2,4,42}	27 N ⁴	12 N ⁴	1 ^{4,5}	MB MB ^{2,4,42,43}	IF IF ^{2,4,43}	V ^{2,4,43}	
<i>Sylvia mystacea</i>	46 N ^{2,42}	31 N ⁴²	30 N ^{2,42}	9 N ^{2,4,42}	1 ^{4,5}	MB MB ^{2,4,42,43}	I I ^{2,4,43}	V ^{2,4,43}	
<i>Sylvia conspicillata</i>	44 N ^{2,42}	27 N ^{2,4}	37 N ^{2,42}	19 N ⁴	1 ^{2,4,5}	MB MB ^{2,4,42,43}	IF IF ^{2,4,43}	V ^{2,4,43}	
ALAUDIDAE									
<i>Melanocorypha bimaculata</i>	50 N ^{2,33}	29 N ³³	36 N ^{2,33}	13 N ⁴	2 ^{2,5}	UB UB ^{2,4,33}	IS IS ^{2,4}	G ^{2,4}	
<i>Calandrella brachydactyla (1)</i>	55 N ²	25 N ⁴	40 N ²	10 N ⁴	1 ²	UB UB ^{2,4}	IS IS ^{2,4}	G ^{2,4}	
<i>Calandrella rufescens</i>	52 N ²	27 N ²	42 N ²	25 N ²	1 ⁵	UB UB ²	I IS ²	G ^{2,4}	
PASSERIDAE									
<i>Passer hispaniolensis</i>	46 N ²	30 N ²	41 N ²	23 N ⁹	1 ⁹	MB MB ^{2,9}	IS IS ⁹	G ⁹	
<i>Carpospiza brachydactyla</i>	40 N ⁹	27 N ⁹	30 N ⁹	10 N ⁹	1 ⁹	UB UB ^{2,9}	IS S ^{2,9}	G ^{2,9}	
<i>Motacilla alba alba (1)</i>	74 N ²	22 N ^{2,36}	40 N ^{2,36,38}	8 N ^{2,17,31}	1 ^{4,5}	UB UB ^{2,4,17}	I I ²	G ^{2,4}	
<i>Motacilla alba yarrelli</i>	59 N ^{2,17}	49 N ^{2,17}	49 N ^{2,17}	22 N ^{2,4,17}	1 ²	UB UB ^{2,17}	I I ²	G ²	

<i>Motacilla flava flavissima</i>	56 N ^{2,17}	47 N ^{2,17}	17 N ⁴	4 N ⁴	1 ²	UB	UB ^{2,4}			2,4	G	2,4
<i>Motacilla flava flava</i> (1)	64 N ^{2,17,33}	19 N ^{2,17}	18 N ⁴	35 S ^{4,34}	1 ^{2,4}	UB	UB ^{2,4}			2,4	G	2,4
<i>Motacilla flava cinereocapilla</i>	47 N ^{2,17}	36 N ^{2,17}	18 N ⁴	12 N ⁴	1 ⁴	UB	UB ^{2,4}			2,4	G	2,4
<i>Motacilla flava lutea</i> (1)	52 N ^{2,17}	36 N ^{2,17}	18 N ⁴	27 S ^{4,34}	1 ²	UB	UB ^{2,4}			2,4	G	2,4
<i>Motacilla flava feldegg</i>	48 N ^{2,17}	28 N ^{2,17}	30 N ^{2,33}	4 S ⁴	1 ²	UB	UB ^{2,4}			2,4	G	2,4
<i>Motacilla flava thunbergi</i> (1)	71 N ^{2,17}	57 N ^{17,33}	18 N ⁴	35 S ^{4,34}	1 ²	UB	UB ^{2,4}			2,4	G	2,4
<i>Anthus campestris</i> (1)	60 N ²	28 N ²	42 N ²	2 S ⁴	1 ^{2,5}	UB	UB ^{2,4}		IS	2,4	G	2,4
<i>Anthus trivialis</i> (1)	71 N ²	38 N ²	20 N ²	23 S ^{2,4}	1 ⁵	MB	MB ^{2,4}		IS	2,4	G	2,4
<i>Anthus pratensis</i>	71 N ²	41 N ²	63 N ²	15 N ⁴	1 ^{2,5}	UB	UB ^{2,4}			2,4	G	2,4
<i>Anthus cervinus</i> (1)	71 N ²	62 N ²	37 N ²	6 S ⁴	1 ^{2,5}	UB	UB ^{2,4}			2,4	G	2,4
<i>Anthus spinoletta</i> (1)	45 N ²	35 N ²	45 N ²	14 N ²	1 ²	UB	UB ^{2,33}			2,39	G	2
FRINGILLIDAE												
<i>Carduelis carduelis carduelis</i>	64 N ²	28 N ²	61 N ²	23 N ²	1 ²	D	D ²	IS	IS	2	G	2
<i>Carduelis cannabina</i>	66 N ^{2,9}	30 N ²	58 N ²	23 N ⁹	1 ^{2,9}	D	UB ^{2,9}	S	S	9	G	9
<i>Emberiza cineracea</i>	39 N ^{2,7}	37 N ^{2,7}	20 N ⁷	14 N ^{2,7}	1 ²	MB	UB ^{2,7}		S	2,7	-	-
<i>Emberiza hortulana</i>	67 N ^{2,7}	35 N ^{2,7}	21 N ⁷	7 N ⁷	1 ^{2,5}	MB	UB ^{2,7}		IS	2,7	VG	2
<i>Emberiza caesia</i>	41 N ^{2,7}	31 N ^{2,7}	20 N ^{2,7}	10 N ⁷	1 ²	UB	UB ^{2,7}	IS	IS	2,7	G	2,7
<i>Miliaria calandra</i>	58 N ^{2,7}	28 N ²	51 N ²	17 N ⁷	2 ^{2,5}	UB	UB ⁷	IS	IS	2,7	G	2

EP-O FLYWAY

Scientific name	Distribution				Mean body mass	Habitat		Diet		Foraging mode
	BR range		NBR range			BR	NBR	BR	NBR	
	N limit	S limit	N limit	S limit						
PHASIANIDAE										
<i>Coturnix coturnix coturnix</i> (1)	62 N ^{1,2}	22 N ^{1,2,55}	31 N ²	8 N ^{1,2,55}	3 ^{1,5}	UB	UB ^{1,33,39,55}	IS	IS ^{1,2,33,55}	G ^{2,33}
<i>Coturnix japonica</i>	58 N ^{1,55}	32 N ^{1,38,55}	38 N ^{1,38}	18 N ^{1,31,36,55}	2 ⁵	UB	UB ^{1,33,36,38,55}	G	P ^{1,33,39,55}	G ³³
ANATIDAE										
<i>Anser erythropus</i>	73 N ¹	64 N ¹	38 N ¹	24 N ¹	3 ^{1,5}	UB	UB ^{1,52}	P	P ^{1,52}	V ^{1,52}
PICIDAE										
<i>Jynx torquilla</i> (1)	64 N ^{2,25}	31 N ^{2,25}	36 N ^{2,31}	9 N ^{2,31}	2 ^{2,25}	WB	MB ^{2,25}	I	I ^{2,25}	G ^{2,25}
UPUPIDAE										
<i>Upupa epops</i> (1)	53 N ^{1,2}	8 N ^{1,31}	35 N ^{1,2}	8 N ^{1,2}	2 ⁵	UB	UB ^{1,2,31}	I	I ^{1,2}	G ^{1,2}
CORACIIDAE										
<i>Eurystomus orientalis</i>	46 N ^{1,3,31}	20 N ^{1,3,31}	24 N ^{1,3,31}	9 S ^{1,3,31}	3 ^{1,5}	WB	WB ^{1,3}	I	I ^{1,3}	A ^{1,3}
HALCYONIDAE										
<i>Halcyon coromanda</i>	45 N ^{1,3}	20 N ¹	19 N ^{1,3}	8 S ^{1,3}	2 ^{1,3,5}	WB	WB ^{1,3}	VI	VI ^{1,3}	P ^{1,3}
MEROPIIDAE										
<i>Merops philippinus</i>	37 N ^{1,3}	17 N ^{1,31}	32 N ^{1,31}	10 S ^{1,3,31}	2 ^{1,3}	MB	MB ^{1,3}	I	I ^{1,3}	S ^{1,3}
CUCULIDAE										
<i>Clamator coromandus</i>	36 N ¹	12 N ¹	24 N ¹	9 S ¹	2 ¹	MB	MB ¹	I	I ¹	VG ^{1,39}
<i>Cuculus sparverioides</i>	40 N ¹	9 N ¹	25 N ¹	10 S ¹	3 ^{1,5}	WB	WB ^{1,17,31}	I	I ¹	V ^{1,39}
<i>Cuculus fugax hyperythrus</i>	54 N ¹	30 N ^{1,17}	25 N ¹	5 S ¹	2 ¹	WB	WB ¹	I	I ¹	V ¹
<i>Cuculus canorus canorus</i> (1)	70 N ^{1,2}	20 N ^{1,2}	25 N ^{1,2}	10 N ^{1,2}	3 ¹	D	D ^{1,2}	I	I ¹	VG ²
<i>Cuculus micropterus</i>	56 N ¹	18 N ^{1,17}	18 N ¹	9 S ¹	3 ¹	WB	WB ^{1,17,31}	I	I ¹	V ¹
<i>Cuculus saturatus saturatus</i>	70 N ¹	18 N ¹	18 N ^{1,17}	33 S ^{1,17}	2 ¹	WB	WB ^{1,31,37}	I	I ¹	VG ^{2,37,39}
<i>Cuculus poliocephalus</i>	45 N ¹	18 N ¹	25 N ¹	6 N ¹	2 ¹	WB	WB ¹	I	I ¹	V ¹
<i>Chrysococcyx maculatus</i>	32 N ¹	28 N ¹	22 N ¹	1 S ¹	1 ¹	WB	WB ¹	I	I ¹	V ^{1,*}
<i>Surniculus lugubris</i>	35 N ¹	10 N ¹	34 N ¹	9 S ¹	2 ¹	WB	WB ¹	I	I ¹	VS ^{1,39,60}
APODIDAE										
<i>Collocalia brevirostris brevirostris</i>	34 N ^{1,6}	15 N ^{1,6}	34 N ^{1,6}	1 N ^{1,6}	1 ⁶	D	D ^{1,6}	I	I ^{1,6}	A ^{1,6}
<i>Hirundapus caudacutus</i>	60 N ^{1,6}	35 N ^{1,6}	6 S ^{1,6}	44 S ^{1,6}	3 ^{1,6}	D	D ^{1,6}	I	I ^{1,6,37}	A ^{1,6,37}

<i>Apus pacificus</i>	67 N ⁶	27 N ^{1,6}	20 N ^{1,6}	44 S ^{1,6}	2 ⁶	D D 1,6,31	I I 1,6,37	A 1,6,37
STRIGIDAE								
<i>Otus brucei</i>	47 N ¹	23 N ¹	24 N ¹	18 N ¹	3 ¹	MB MB 1,19	VI VI 1,19	P 1,19
<i>Otus scops sunia</i>	55 N ^{1,19}	30 N ¹	25 N ^{1,19}	1 N ^{19,31}	2 ⁵	WB WB 1,19,31	I I 1,19	P 1,19
<i>Ninox scutulata scutulata</i>	53 N ¹	26 N ^{1,31}	18 N ^{1,31}	10 S ^{1,31}	3 ^{1,5}	WB WB 1,19,31	VI VI 1,19	S 1,19
<i>Asio otus (3)</i>	65 N ¹	35 N ^{1,31}	38 N ^{1,31}	21 N ^{1,19}	3 ^{1,5}	MB MB 1,2,19	V V 1,19	P 1,19
<i>Asio flammeus (1) (3)</i>	70 N ^{1,2}	44 N ^{1,2}	45 N ^{1,2}	6 N ¹	3 ^{2,5}	UB UB 1,2,19,39	V V 1,2,19	P 1,2,19
CAPRIMULGIDAE								
<i>Caprimulgus indicus</i>	50 N ^{1,26}	20 N ^{1,26}	30 N ²⁶	9 S ^{1,26}	2 ²⁶	WB WB 1,26	I I 1,26	A 1,26
COLUMBIDAE								
<i>Streptopelia orientalis</i>	62 N ¹	40 N ¹	46 N ¹	8 N ^{1,31}	3 ^{1,5}	WB WB 1,31	S S 1,59	G 1
<i>Streptopelia tranquebarica</i>	40 N ^{1,31}	27 N ^{1,31,39}	30 N ^{1,36}	9 N ^{1,31}	3 ^{1,5}	MB MB 1	S S 1,59	G 1
GRUIDAE								
<i>Grus virgo (1)</i>	52 N ²	38 N ²	32 N ^{1,2,33}	12 N ^{1,33,39}	3 ¹	UB UB 1,33,39,53	G G 1,39,53	G 1,2,53
<i>Grus grus (1)</i>	68 N ^{1,2}	43 N ^{2,33,39}	40 N ^{1,2,33,39}	16 N ^{2,39}	3 ^{1,5,39}	UB UB 1,33,39,53	G G 1,2,33,39,53	G 1,2,53
SCOLOPACIDAE								
<i>Scolopax rusticola</i>	61 N ^{2,54}	35 N ^{1,2}	37 N ^{1,2}	1 N ^{1,54}	3 ^{1,2}	WB WB 1,233,54	I I 1,2,33	G 1,2
<i>Scolopax rusticola</i>	35 N ³⁹	27 N ^{33,39}	34 N ³⁹	8 N ³⁹	3 ^{1,2}	WB WB 39	I I 1,2,33,39	G 1,2,39
CHARADRIIDAE								
<i>Vanellus vanellus (1)</i>	58 N ^{2,54}	37 N ^{2,54}	36 N ^{1,2,54}	15 N ^{1,33}	3 ^{1,5}	UB UB 1,36,38,39,54	I I 1,2,39	G 2,39
<i>Vanellus gregarius (1)</i>	56 N ^{2,54}	47 N ^{1,2,54}	35 N ^{2,54}	20 N ^{2,54}	3 ^{1,5}	UB UB 1,2,54	I I 1,2	G 2
<i>Charadrius veredus</i>	52 N ^{1,54}	40 N ^{1,54}	5 N ^{1,54}	38 S ³⁷	2 ¹	UB UB 1,33,54	I I 1	G 1
ACCIPITRIDAE								
<i>Aviceda leuphotes</i>	40 N ¹	20 N ¹	20 N ¹	5 S ^{1,31}	3 ¹	WB WB 1,12,13,31	VI VI 1,12,13	PS 1,13
<i>Pernis ptilorhynchus orientalis</i>	60 N ¹	35 N ¹	26 N ¹	8 S ¹	3 ¹	WB WB 1,13	I I 1,13	VG 1,12
<i>Milvus migrans migrans (1)</i>	67 N ^{1,2}	1 N ^{1,31}	30 N ^{1,31}	1 N ^{1,31}	3 ^{1,2}	D D 1,2,13,31	VI VI 1,2,13	PA 1,13
<i>Aegypius monachus</i>	50 N ¹	28 N ¹	50 N ¹	23 N ¹	3 ¹	D D 1	V V 1	G 1
<i>Circaetus gallicus gallicus (1)</i>	49 N ²	40 N ²	33 N ^{1,2}	8 N ^{1,2}	3 ^{1,5}	D D 1,2,13,39	V V 1,2,13	PA 1,2,13
<i>Circus cyaneus cyaneus</i>	70 N ^{1,2}	43 N ^{1,2}	46 N ¹	18 N ^{1,2}	3 ⁵	UB UB 1,2,13,33	V V 1,2,33,13	P 1,2,13
<i>Circus macrourus (1)</i>	55 N ^{1,2}	41 N ^{1,2}	40 N ^{1,2}	6 N ^{1,2}	3 ^{1,2}	UB UB 1,2,13	VI VI 1,13	PA 1,2,13
<i>Circus melanoleucos</i>	55 N ¹	40 N ¹	30 N ¹	5 N ¹	3 ¹	UB UB 1,13,31	VI VI 1,13	P 1,13
<i>Circus pygargus (1)</i>	57 N ²	40 N ^{1,2}	32 N ^{1,2}	6 N ¹	3 ^{1,2}	UB UB 1,13,31	VI VI 1,13	P 1,13
<i>Accipiter soloensis</i>	43 N ¹	20 N ¹	23 N ¹	10 S ¹	3 ⁵	WB WB 1,13,31	VI VI 1,13	P 1,13

<i>Accipiter gularis</i>	56 N ¹	30 N ¹	30 N ¹	10 S ¹	3 ⁵	WB WB 1,12,13,31	V V 1,13	P 1,13	
<i>Accipiter nisus</i> (1)	70 N ¹	30 N ¹	50 N ¹	6 N ¹	3 ²	WB WB 1,13	V V 1,2,13	PA 1,2,13	
<i>Accipiter gentilis gentilis</i>	70 N ²	31 N ¹	45 N ²	20 N ^{1,2}	3 ¹	WB WB 1,2,13	V V 1,13	P 1,13	
<i>Butastur indicus</i>	50 N ¹	30 N ¹	30 N ¹	8 S ¹	3 ⁵	WB WB 1,13,31	V V 1,13	P 1,13	
<i>Buteo buteo vulpinus</i> (1)	62 N ^{1,2,12}	40 N ¹	38 N ^{1,33}	25 N ^{1,17,33}	3 ¹²	D D 1,13,17	VI VI 1,13	P 1,12,13	
<i>Buteo buteo japonicus</i>	62 N ^{1,12}	30 N ^{1,12}	40 N ¹	6 N ^{1,17}	3 ¹²	D WB 1,12,13	VI VI 1,13	P 1,12,13	
<i>Buteo rufinus</i> (1)	53 N ¹	40 N ¹	40 N ¹	23 N ¹	3 ²	D D 1,13	V V 1,13	P 1,2,13	
<i>Buteo hemilasius</i>	53 N ¹	26 N ¹	41 N ¹	23 N ¹	3 ⁵	UB UB 1,13	VI VI 1,12,13	P 1,12,13	
<i>Aquila clanga</i> (1)	60 N ^{1,2}	43 N ¹	42 N ¹	9 N ^{1,2}	3 ^{1,2}	WB UB 1,12,13,31	V VI 1,13	P 1,13	
<i>Aquila nipalensis nipalensis</i>	55 N ¹	35 N ¹	30 N ¹	15 N ¹	3 ^{1,2}	UB UB 1,12,13,31	V V 1,12,13	P 1,12,13	
<i>Aquila heliaca</i> (1)	60 N ¹	45 N ¹	55 N ¹	19 N ¹	3 ¹	WB UB 1,2	V V 1,2,13	P 1,2,13	
<i>Hieraaetus pennatus</i> (1)	58 N ¹	30 N ^{1,2}	30 N ^{1,2}	8 N ^{1,2}	3 ^{1,5}	WB WB 1,13,31	V V 1,13	P 1,13	
FALCONIDAE									
<i>Falco tinnunculus</i> (1)	65 N ¹	20 N ^{1,31}	45 N ^{1,31}	5 N ^{1,31}	3 ¹	UB UB 1,2,13	VI VI 1,13	P 1,2,13	
<i>Falco columbarius</i> (3)	70 N ¹	45 N ¹	45 N ¹	15 N ¹	3 ¹	D D 1,2,12,13	V V 1,13	PA 1,2,13	
<i>Falco subbuteo</i> (1)	66 N ^{1,2}	25 N ^{1,2}	35 N ^{1,2}	16 N ^{1,2}	3 ^{1,2}	MB MB 1,12,13,31	VI VI 1,12,13	A 1,2,12,13	
<i>Falco cherrug</i> (1)	58 N ²	32 N ^{1,2}	38 N ¹	24 N ¹	3 ¹	UB UB 1,2,13	V V 1,2,12,13	P 1,2,13	
<i>Falco peregrinus</i> (1) (3)	77 N ^{1,2}	35 N ¹	50 N ¹	5 S ^{1,31}	3 ^{1,4,5}	UB UB 2,13,17,31	V V 1,13	A 1,2,13	
ARDEIDAE									
<i>Bubulcus ibis</i> (3)	38 N ^{1,2}	7 N ^{1,2}	25 N ^{1,2}	10 S ^{1,2}	3 ^{1,5}	UB UB ¹	VI VI 1,2	G 1,2	
LANIIDAE									
<i>Lanius tigrinus</i>	44 N ¹⁰	24 N ¹⁰	25 N ¹⁰	9 S ¹⁰	1 ⁵	WB WB 10,31	I I 10	P 10	
<i>Lanius bucephalus</i>	51 N ¹⁰	26 N ¹⁰	42 N ¹⁰	20 N ¹⁰	2 ¹⁰	MB MB 10,33,38	I I 10,38	P 10,38	
<i>Lanius isabellinus isabellinus</i>	50 N ¹⁰	35 N ¹⁰	30 N ¹⁰	20 N ¹⁰	1 ^{10,39}	UB UB 10	VI VI 10	P 10	
<i>Lanius cristatus cristatus</i>	70 N ¹⁰	45 N ¹⁰	28 N ¹⁰	3 N ¹⁰	1 ^{5,10}	D D 10	VI VI 10	P 10	
<i>Lanius cristatus superciliosus</i>	48 N ¹⁰	35 N ¹⁰	24 N ¹⁰	10 S ¹⁰	1 ^{5,10}	D D 10	VI VI 10	P 10	
<i>Lanius tephronotus</i>	39 N ¹⁰	25 N ¹⁰	39 N ¹⁰	14 N ¹⁰	2 ^{5,10}	MB MB 10	VI VI 10	P 10	
<i>Lanius sphenocercus</i>	50 N ¹⁰	30 N ¹⁰	43 N ¹⁰	21 N ¹⁰	2 ^{5,10}	D D 10,33,36	VI VI 10	P 10	
CORVIDAE									
<i>Oriolus oriolus</i> (1)	60 N ^{2,33}	22 N ^{2,33}	30 N ^{2,33}	6 N ^{2,33,39}	2 ⁵	WB WB 2,33,39	I IF 2,33,39	V 2,39	
<i>Oriolus chinensis</i>	50 N ^{33,39}	18 N ³³	30 N ³³	1 N ^{33,39}	2 ⁵	WB WB 17,31,33,39	IF IF 33,39	V 31	
<i>Coracina melaschista</i>	38 N ³⁹	24 N ³⁶	26 N ³⁶	22 N ^{36,39}	2 ⁵	WB WB 17,31,36,39	I I 39,49	V 39,49	
<i>Pericrocotus roseus</i>	36 N ³⁹	20 N ^{17,36,39}	28 N ³⁹	10 N ^{17,31}	1 ⁵	WB WB 31,39	I I 31,39	VS 33,*	

<i>Pericrocotus cantonensis</i>	38 N ³⁶	22 N ³⁶	25 N ³⁶	9 N ^{31,36}	1 ⁵	WB WB	17,31,36			31,36	VS *
<i>Pericrocotus divaricatus</i>	54 N ^{17,33}	22 N ^{17,36}	22 N ^{17,31,33}	5 S ^{31,33,36}	1 ⁵	WB WB	31,33,36,38			33	VS 29,33
<i>Pericrocotus ethologus</i>	40 N ^{17,36}	28 N ^{17,36,39}	35 N ³⁹	18 N ³¹	1 ⁵	WB WB	31,36,39			39,49	V 39,49
<i>Dicrurus macrocercus</i>	44 N ^{17,36,50}	18 N ^{31,36}	30 N ^{31,50}	1 N ³¹	2 ⁵	MB MB	17,31,36,48			31,39,49	S 32,39
<i>Dicrurus leucophaeus longicaudatus</i>	37 N ^{17,39}	25 N ³⁹	26 N ³⁹	6 N ³⁹	2 ^{5,39}	WB WB	39			39,49	S 39
<i>Dicrurus leucophaeus leucophaeus</i>	40 N ^{17,36}	21 N ^{17,36}	26 N ³⁶	9 N ³¹	2 ^{5,39}	WB WB	31,39			39,49	S 39
<i>Terpsiphone paradisi</i>	45 N ^{17,33}	22 N ²²	24 N ^{31,36}	5 S ^{17,31,36}	1 ⁵	WB WB	17,31,36			39	S 39
<i>Terpsiphone atrocaudata</i>	40 N ^{17,38}	22 N ^{17,31,36}	15 N ^{31,36}	0 ^{17,47}	1 ⁵	WB WB	17,33,36,38			31	S 31,32,47
MUSCICAPIDAE											
<i>Monticola cinclorhynchus</i>	37 N ³⁵	25 N ³⁵	22 N ³⁵	9 N ³⁵	2 ^{5,35}	WB WB	35			35	P 35,39,49
<i>Monticola gularis</i>	55 N ³⁵	37 N ³⁵	26 N ³⁵	8 N ³⁵	2 ^{5,35}	WB WB	35			35	VG 35
<i>Monticola rufiventris</i>	37 N ³⁵	22 N ³⁵	34 N ³⁵	20 N ³⁵	2 ³⁵	WB WB	35			35	VG 35
<i>Monticola solitarius philippensis</i>	53 N ³⁵	24 N ³⁵	30 N ³⁵	4 S ³⁵	2 ³⁵	UB UB	35			35	P 2,35,39
<i>Zoothera sibirica</i>	69 N ³⁵	35 N ³⁵	23 N ³⁵	9 S ³⁵	2 ³⁵	WB WB	35			35	VG 2,35
<i>Zoothera dauma</i>	62 N ³⁵	22 N ³⁵	37 N ³⁵	13 N ³⁵	3 ³⁵	WB WB	35			35	G 35
<i>Turdus hortulorum</i>	65 N ³⁵	43 N ³⁵	34 N ³⁵	19 N ³⁵	2 ³⁵	WB WB	35			35	G 35
<i>Turdus cardis</i>	45 N ³⁵	26 N ³⁵	26 N ²⁵	8 N ³⁵	-	WB WB	35	IF	IF	35	VG 35
<i>Turdus merula merula</i>	50 N ³⁵	22 N ³⁵	24 N ^{2,35}	18 N ^{2,35}	3 ^{2,35}	WB WB	35	IF	IF	35	VG 35
<i>Turdus rubrocanus</i>	43 N ³⁵	24 N ³⁵	28 N ³⁵	18 N ³⁵	2 ³⁵	WB WB	35	IF	IF	35	VG 35
<i>Turdus feae</i>	45 N ³⁵	40 N ³⁵	23 N ³⁵	12 N ²⁵	-	WB WB	35	IF	IF	35	VG 35
<i>Turdus obscurus</i>	65 N ³⁵	48 N ³⁵	29 N ³⁵	5 S ³⁵	2 ³⁵	WB WB	35	IF	IF	35	VG 35
<i>Turdus pallidus</i>	54 N ³⁵	35 N ³⁵	41 N ³⁵	20 N ³⁵	2 ³⁵	WB WB	35	IF	IF	35	VG 35
<i>Turdus chrysolaus</i>	55 N ³⁵	36 N ³⁵	37 N ³⁵	14 N ³⁵	2 ³⁵	WB MB	35		IF	35	VG 35
<i>Turdus ruficollis atrogularis</i>	67 N ³⁵	45 N ³⁵	44 N ³⁵	20 N ³⁵	2 ³⁵	WB UB	35			35	VG 35
<i>Turdus ruficollis ruficollis</i>	60 N ³⁵	42 N ³⁵	35 N ³⁵	20 N ³⁵	2 ³⁵	D D	35			35	VG 35
<i>Turdus naumanni eunomus</i>	72 N ³⁵	51 N ³⁵	45 N ³⁵	20 N ³⁵	2 ³⁵	WB D	35	IF	IF	35	VG 35
<i>Turdus naumanni naumanni</i>	63 N ³⁵	51 N ³⁵	47 N ³⁵	23 N ³⁵	2 ^{5,35}	WB D	35	IF	IF	35	VG 35
<i>Rhinomyias brunneata</i>	33 N ^{17,36}	23 N ^{17,36}	15 N ³¹	1 N ³¹	-	WB WB	17,31,36			39	S *
<i>Muscicapa griseisticta</i>	55 N ³³	31 N ³³	19 N ^{31,33}	10 S ^{31,33}	1 ⁵	WB WB	17,31,33,36			31,46	S 29,46
<i>Muscicapa sibirica sibirica</i>	62 N ^{33,39}	34 N ^{33,39}	25 N ^{36,39}	9 S ^{31,39}	1 ⁵	WB WB	17,31,33,36,47			31	S 32,47
<i>Muscicapa dauurica dauurica</i>	60 N ³³	27 N ³³	30 N ^{31,33}	10 S ^{2,17,31}	1 ^{2,5}	WB WB	2,17,33,47			2,33	S 2,29,47
<i>Muscicapa ferruginea</i>	40 N ¹⁷	22 N ^{17,36}	18 N ^{31,36,39}	9 S ^{17,31}	1 ⁵	WB WB	17,31,39,47			39	S 39,47
<i>Ficedula zanthopygia</i>	55 N ^{17,31}	28 N ^{17,36}	15 N ^{17,31,36}	9 S ^{17,31}	1 ⁵	WB WB	17,31,36,47,48			31	V *

<i>Ficedula narcissina</i>	54 N ^{17,31,33}	26 N ^{17,33}	32 N ³³	3 S ^{31,33}	1 5	WB WB	17,31,33,36,47			31	S	47,*
<i>Ficedula mugimaki</i>	61 N ^{17,33}	41 N ^{17,36}	25 N ^{17,36}	10 S ^{31,47}	1 5	WB WB	17,31,33,38,47			31,47	S	29,47
<i>Ficedula hodgsonii</i>	40 N ^{17,36}	25 N ^{17,36}	40 N ³⁹	15 N ^{31,36}	1 5	WB WB	17,31,39			31	S	39
<i>Ficedula strophciata</i>	40 N ^{17,36}	21 N ^{17,36}	35 N ^{17,39}	10 N ^{17,31,36}	1 39	WB WB	17,31,39			31	S	39
<i>Ficedula parva albicilla</i>	65 N ^{33,39}	46 N ^{33,39}	30 N ^{2,33,39}	8 N ^{2,33,39}	1 5	WB WB	2,31,33,36,39			2,39	S	2,39
<i>Ficedula subrubra</i>	36 N ³³	30 N ³³	10 N ^{17,33}	6 N ^{17,33}	1 5	WB WB	17,39			39	S	39
<i>Ficedula superciliaris</i>	37 N ^{17,39}	24 N ^{17,39}	29 N ^{17,39}	13 N ^{17,39}	1 5	WB WB	31,39			39	S	39
<i>Cyanoptila cyanomelana</i>	46 N ³³	30 N ³³	25 N ³⁶	9 S ^{31,47}	1 5	WB WB	31,33,36,47,48			31,47	S	47
<i>Eumyias thalassina</i>	35 N ^{17,36}	22 N ^{17,36,39}	30 N ^{31,39}	8 N ³¹	1 5,39	WB WB	17,31,36,39			39	S	32,39
<i>Cyornis rubeculoides</i>	34 N ³⁹	20 N ³⁹	29 N ³⁹	8 N ³⁹	1 5,39	WB WB	17,39			39	S	39
<i>Culicicapa ceylonensis</i>	35 N ^{17,31,39}	18 N ^{17,39}	35 N ^{17,39}	15 N ^{31,39}	1 5	WB WB	31,39,49			39,49	S	39,49
<i>Erithacus akahige</i>	55 N ^{33,38}	30 N ^{33,38}	27 N ³³	20 N ^{31,33}	- -	WB WB	31,33,36			31	G	31
<i>Luscinia sibilans</i>	64 N ³³	35 N ³³	25 N ³⁶	18 N ^{31,36,48}	- -	WB WB	17,31,33,36			31	VG	31
<i>Luscinia calliope</i>	68 N ^{17,33}	30 N ^{17,33,36}	30 N ³³	6 N ^{17,33}	1 5	D MB	31,33,38			31,33	VG	31
<i>Luscinia svecica (1)</i>	70 N ^{2,33}	30 N ²	34 N ²	9 N ^{2,31}	1 2	MB MB	2,31,33			2	VG	2
<i>Luscinia cyane</i>	60 N ^{17,33}	31 N ^{17,33}	28 N ^{31,33,50}	4 S ^{31,33,47}	1 5	WB WB	17,31,33,47			31	VG	31
<i>Tarsiger cyanurus</i>	39 N ²	23 N ²	27 N ²	18 N ²	1 5	WB WB	2,31			2	G	2,*
<i>Tarsiger cyanurus</i>	67 N ²	40 N ²	37 N ²	12 N ²	1 5	WB WB	2,31			2	G	2,*
<i>Phoenicurus ochruros (1)</i>	50 N ²	28 N ²	34 N ²	11 N ²	1 2,5	D D	2,33			2,33	PG	2
<i>Phoenicurus aureus</i>	56 N ³³	35 N ^{33,50}	39 N ^{33,38,50}	18 N ^{31,36}	1 5	WB MB	31,33,38		IF	31,33	-	-
<i>Phoenicurus frontalis</i>	42 N ^{17,36}	27 N ¹⁷	34 N ³⁶	19 N ^{31,48}	1 5	D D	17,31,36,48			31,49	P	49,51
<i>Saxicola torquata maura (1)</i>	70 N ²	20 N ²	34 N ²	5 N ²	1 5	UB MB	2,31			2	P	2
<i>Oenanthe xanthopyrmyna chrysopygia (1)</i>	40 N ²	32 N ²	34 N ²	20 N ^{2,39}	1 5	UB UB	2,17,39			2,39	G	2
<i>Oenanthe deserti (1)</i>	51 N ²	30 N ²	34 N ²	16 N ²	1 5	UB UB	2,33			2	GP	2
<i>Oenanthe isabellina (1)</i>	51 N ²	35 N ²	35 N ^{2,39}	18 N ^{2,39}	1 2,5	UB UB	2,33,39			2,39	GP	2
STURNIDAE												
<i>Saroglossa spiloptera</i>	33 N ⁴¹	27 N ⁴¹	28 N ⁴¹	19 N ⁴¹	2 41	WB MB	17,31,39,41	IF	IF	39,41	V	41
<i>Sturnus sericeus</i>	36 N ⁴¹	18 N ⁴¹	29 N ⁴¹	20 N ^{36,41}	- -	MB MB	31,41	-	-	-	VG	41
<i>Sturnus sturninus</i>	55 N ⁴¹	36 N ⁴¹	23 N ⁴¹	9 S ⁴¹	3 41	MB MB	17,31,33,41		IF	41	VS	41
<i>Sturnus philippensis</i>	45 N ⁴¹	35 N ⁴¹	29 N ⁴¹	4 N ^{31,41}	- -	WB MB	38,41,45		IF	41	V	41
<i>Sturnus roseus</i>	50 N ⁴¹	25 N ⁴¹	27 N ⁴¹	6 N ⁴¹	2 2,41	UB UB	2,39,41		G	2,39,41	G	2,41
<i>Sturnus vulgaris (1)</i>	61 N ⁴¹	39 N ⁴¹	48 N ⁴¹	19 N ⁴¹	2 5,41	MB UB	39,41		G	2,41	G	2,41

<i>Sturnus cineraceus</i>	54 N ⁴¹	35 N ⁴¹	32 N ⁴¹	18 N ⁴¹	- -	UB UB	17,33,36,41	IF IF	41	G	41
HIRUNDINIDAE											
<i>Riparia riparia riparia</i> (1) (3)	70 N ⁸	35 N ³¹	23 N ^{8,17}	4 S ^{8,17,31}	1 ⁸	D D	8,31		2,8	A	2,8
<i>Riparia riparia diluta</i>	52 N ^{8,17}	23 N ^{8,17}	35 N ^{8,17,31}	20 N ^{8,17,31}	1 ⁸	D D	8,31		2,8	A	2,8
<i>Hirundo rupestris</i> (1)	50 N ²	18 N ^{2,8}	32 N ^{2,8}	13 N ^{2,8}	1 ⁸	UB UB	2,8		8	A	8
<i>Hirundo rustica rustica</i> (1)	68 N ^{2,8}	20 N ^{2,8}	34 N ^{2,8}	10 S ^{2,8}	1 ^{2,8}	UB UB	2,8,39		2,8	A	2,8
<i>Hirundo smithii filifera</i>	42 N ⁸	8 N ⁸	35 N ⁸	8 N ⁸	1 ⁸	D D	8		8	A	8
<i>Hirundo daurica daurica</i>	55 N ^{8,17}	19 N ^{8,17}	36 N ^{8,17}	16 N ^{8,17}	1 ⁸	UB UB	2,8		2,8	A	2,8
<i>Delichon urbica</i> (1)	70 N ⁸	28 N ⁸	30 N ⁸	10 N ^{8,31}	1 ⁸	D D	2,8,31,36		2,8	A	2,8
<i>Delichon dasypus</i>	52 N ⁸	22 N ⁸	34 N ⁸	10 S ^{8,31}	1 ⁸	D D	8,31		8	A	8
ZOSTEROPIDAE											
<i>Zosterops erythropleura</i>	54 N ^{17,33}	35 N ³³	26 N ³⁶	6 N ³³	1 ⁵	MB WB	17,31,33,36		31,33	V	33
SYLVIIDAE											
<i>Urosphena squameiceps</i>	48 N ⁴²	31 N ⁴²	26 N ^{31,42}	12 N ^{31,42}	1 ⁴²	WB WB	42		33,42	G	33,42
<i>Cettia canturians</i>	37 N ⁴²	29 N ⁴²	26 N ^{31,42}	17 N ^{31,42}	1 ⁴²	MB MB	17,42		42	G	42
<i>Cettia diphone</i>	48 N ^{17,42}	36 N ⁴²	26 N ⁴²	21 N ⁴²	1 ⁵	MB MB	17,42		42	G	42
<i>Bradypterus thoracicus</i>	60 N ⁴²	22 N ⁴²	33 N ⁴²	15 N ⁴²	1 ⁵	MB MB	31,42		42	G	42
<i>Bradypterus tacsanowskii</i>	57 N ⁴²	23 N ⁴²	28 N ⁴²	17 N ⁴²	1 ⁴²	MB UB	33,42		42	G	42
<i>Locustella lanceolata</i>	68 N ^{2,42}	42 N ^{2,42}	30 N ^{2,42}	8 S ^{2,42}	1 ^{2,42}	UB UB	2,42		2	VG	2
<i>Locustella naevia</i> (1)	60 N ⁴²	36 N ⁴²	37 N ⁴²	8 N ^{2,42}	1 ²	MB MB	2,33,42		2,33	VG	2
<i>Locustella certhiola</i>	65 N ⁴²	40 N ⁴²	30 N ⁴²	9 S ^{31,42}	1 ^{2,42}	UB UB	2,42		*	V	*
<i>Locustella ochotensis</i>	61 N ⁴²	42 N ⁴²	18 N ⁴²	9 S ⁴²	1 ⁴²	MB MB	42		33	-	-
<i>Locustella pleskei</i>	48 N ⁴²	30 N ⁴²	27 N ⁴²	20 N ⁴²	1 ⁴²	UB MB	42	- - -	-	-	-
<i>Locustella fasciolata fasciolata</i>	60 N ⁴²	38 N ⁴²	18 N ⁴²	8 S ⁴²	1 ^{5,42}	D D	17,33,42		33	V	*
<i>Locustella fasciolata amnicola</i>	54 N ⁴²	42 N ⁴²	18 N ⁴²	8 S ⁴²	1 ^{5,42}	D D	17,33,42		33	-	-
<i>Acrocephalus bistrigiceps</i>	55 N ⁴²	29 N ⁴²	29 N ⁴²	10 N ⁴²	1 ^{5,42}	MB MB	33,36,38,42		31	V	*
<i>Acrocephalus dumetorum</i>	64 N ^{2,42}	37 N ^{2,42}	34 N ^{2,42}	6 N ^{2,42}	1 ^{2,5}	WB MB	2,33,42		2	V	2
<i>Acrocephalus aedon</i>	57 N ⁴²	40 N ⁴²	29 N ⁴²	8 N ⁴²	1 ^{2,5,42}	D MB	2,42		31	V	*
<i>Hippolias caligata</i>	60 N ^{2,42}	26 N ⁴²	33 N ^{2,42}	6 N ^{2,42}	1 ^{5,42}	D MB	2,33,42		2,42	VG	2
<i>Phylloscopus collybita tristis</i>	70 N ^{2,17,42}	35 N ^{2,42}	33 N ^{2,42}	12 N ⁴²	1 ²	WB WB	2,4,42		2,42	V	2,42
<i>Phylloscopus collybita sindianus</i>	47 N ⁴²	33 N ^{2,42}	35 N ^{2,42}	25 N ^{2,42}	1 ⁴²	D MB	2,42		33,42	V	2,42
<i>Phylloscopus fuscatus</i>	65 N ⁴²	29 N ⁴²	34 N ⁴²	10 N ^{33,42}	1 ^{5,42}	WB D	31,33,42		33,42	VG	42,45
<i>Phylloscopus affinis</i>	40 N ⁴²	24 N ⁴²	30 N ⁴²	8 N ⁴²	1 ⁴²	MB MB	17,42		42	VG	42

<i>Phylloscopus subaffinis</i>	40 N ⁴²	23 N ⁴²	26 N ⁴²	20 N ^{31,42}	1 ⁵	MB MB	31,42			42	VG	42
<i>Phylloscopus griseolus</i>	50 N ⁴²	30 N ⁴²	34 N ⁴²	16 N ⁴²	1 ^{5,42}	MB D	42			42	G	42
<i>Phylloscopus armandii</i>	44 N ⁴²	25 N ⁴²	26 N ⁴²	18 N ⁴²	1 ⁵	WB WB	31,42			42	V	42
<i>Phylloscopus schwarzi</i>	58 N ^{33,42}	38 N ⁴²	24 N ⁴²	9 N ⁴²	1 ^{5,42}	MB MB	42			33,42	VG	33,42,45
<i>Phylloscopus pulcher</i>	39 N ⁴²	24 N ⁴²	34 N ⁴²	15 N ⁴²	1 ⁵	WB WB	42			42	V	42
<i>Phylloscopus proregulus</i>	60 N ^{17,42}	35 N ⁴²	32 N ⁴²	18 N ^{31,42}	1 ^{5,42}	WB WB	17,42			42	V	42
<i>Phylloscopus chloronotus</i>	39 N ^{17,42}	26 N ^{17,42}	34 N ⁴²	18 N ⁴²	1 ⁴²	WB WB	17,42			42	V	42
<i>Phylloscopus inornatus inornatus</i>	70 N ⁴²	40 N ⁴²	30 N ^{31,42}	1 N ^{31,42}	1 ^{5,42}	WB WB	42			42	V	2,42
<i>Phylloscopus inornatus humei</i>	53 N ⁴²	28 N ⁴²	31 N ^{31,42}	16 N ^{31,42}	1 ⁴²	WB WB	42			33,42	V	2,42
<i>Phylloscopus borealis</i>	70 N ⁴²	31 N ⁴²	25 N ⁴²	11 S ⁴²	1 ⁵	WB D	42			42	V	2,42,45
<i>Phylloscopus trochiloides trochiloides</i>	40 N ⁴²	25 N ⁴²	27 N ^{31,42}	9 N ^{31,42}	1 ⁵	WB WB	42			42	V	2,42
<i>Phylloscopus trochiloides plumbeitarsus</i>	64 N ⁴²	42 N ⁴²	20 N ⁴²	9 N ^{31,33,42}	1 ⁵	WB WB	42			33,42	V	2,42
<i>Phylloscopus tenellipes</i>	54 N ^{17,42}	38 N ^{17,42}	21 N ⁴²	9 N ⁴²	1 ^{5,42}	WB WB	42			33,42	V	42
<i>Phylloscopus borealoides</i>	55 N ^{17,42}	34 N ^{17,42}	21 N ⁴²	9 N ⁴²	1 ⁴²	WB WB	38,42			42	V	42
<i>Phylloscopus magnirostris</i>	37 N ⁴²	26 N ⁴²	15 N ⁴²	6 N ⁴²	1 ^{5,42}	MB WB	42			42	V	42
<i>Phylloscopus tytleri</i>	37 N ⁴²	32 N ⁴²	19 N ⁴²	11 N ⁴²	1 ^{5,42}	WB WB	42			42	VS	42
<i>Phylloscopus occipitalis</i>	42 N ⁴²	28 N ⁴²	23 N ⁴²	8 N ⁴²	1 ⁵	WB WB	42			42	VS	42
<i>Phylloscopus coronatus</i>	55 N ^{31,42}	28 N ^{31,42}	28 N ^{31,42}	2 N ^{31,42}	1 ⁴²	WB WB	42			33,42	VS	42
<i>Phylloscopus ijimae</i>	36 N ^{38,42}	33 N ^{38,42}	19 N ^{38,42}	14 N ⁴²	1 ⁴²	WB -	42			42	VS	42
<i>Phylloscopus reguloides</i>	36 N ⁴²	14 N ⁴²	33 N ⁴²	15 N ⁴²	1 ⁴²	WB WB	31,42			42	V	42
<i>Phylloscopus davisoni</i>	30 N ⁴²	16 N ⁴²	26 N ⁴²	16 N ⁴²	1 ⁴²	WB WB	31,36,42			42	V	42
<i>Phylloscopus ricketti</i>	36 N ⁴²	20 N ⁴²	24 N ^{31,42}	15 N ^{31,42}	1 ⁴²	WB WB	31,42			42	VS	42
<i>Seicercus burkii</i>	36 N ⁴²	19 N ⁴²	35 N ⁴²	12 N ⁴²	1 ^{5,42}	WB WB	42			42	VS	42
<i>Sylvia curruca (1)</i>	65 N ^{2,33,42}	35 N ⁴²	33 N ^{2,42}	6 N ^{33,42}	1 ^{2,42}	D MB	2,33,42			2,33,43	V	2,43
<i>Sylvia nana (1)</i>	48 N ⁴²	39 N ⁴²	35 N ⁴²	24 N ^{2,42}	1 ^{2,42}	UB UB	2,42			2,42,43	VG	2,43
ALAUDIDAE												
<i>Calandrella brachydactyla (1)</i>	50 N ²	30 N ²	30 N ²	25 N ²	1 ²	UB UB	2,33		IS	2,33	G	2,33
<i>Calandrella acutirostris</i>	44 N ³⁹	26 N ³⁹	32 N ³⁹	16 N ³⁹	1 ⁵	UB UB	2,17,39	IS	IS	39	G	39
PASSERIDAE												
<i>Petronia xanthocollis</i>	36 N ⁹	26 N ⁹	31 N ⁹	8 N ⁹	1 ^{9,39}	WB WB	2,9,39	G	G	9,39	VG	9
<i>Dendronanthus indicus</i>	47 N ^{33,39}	27 N ^{33,36,39}	30 N ^{31,33,36,39}	9 S ^{17,31,39}	1 ³⁹	WB WB	31,33,39			39	VG	39

<i>Motacilla alba alba</i> (1)	74 N ^{2,17}	36 N ^{2,17}	54 N ⁴	4 S ⁴	1 ⁵	UB UB	2,17,33,39	I	I	2	G	2
<i>Motacilla alba personata</i>	53 N ¹⁷	27 N ¹⁷	37 N ^{17,39}	8 N ^{17,39}	1 ^{2,5}	UB UB	2,17,33,39	I	I	2	G	2
<i>Motacilla flava flava</i> (1)	60 N ^{17,33}	33 N ^{17,39}	36 N ^{2,39}	10 S ^{2,36,47}	1 ²	UB UB	33,36,39,58	I	I	2,31,33,39	G	2,33,39
<i>Motacilla flava leucocephala</i>	52 N ^{2,17}	38 N ^{2,17}	35 N ^{2,39}	20 N ²	1 ²	UB UB	36,39	I	I	2,39	G	2,39
<i>Motacilla flava lutea</i> (1)	52 N ^{2,17}	36 N ^{2,17}	36 N ²	6 N ³⁹	1 ²	UB UB	2,33,39	I	I	2,39	G	2,39
<i>Motacilla flava melanogrisea</i>	49 N ^{2,4}	40 N ¹⁷	36 N ²	11 N ^{2,39}	1 ^{2,39}	UB UB	39,58	I	I	2,31	G	2,31
<i>Motacilla flava thunbergi</i> (1)	73 N ^{2,17}	32 N ¹⁷	37 N ^{33,39}	10 S ²	1 ^{2,39}	UB UB	33,36,39,47,58	I	I	2,33,39	G	2,33
<i>Motacilla flava taivana</i>	70 N ^{2,17}	45 N ^{2,17}	28 N ^{2,33}	10 S ^{33,36,39,47}	1 ³⁹	UB UB	2,33	I	I	2,39	G	2,39
<i>Motacilla flava simillima</i>	60 N ^{2,17}	49 N ^{2,17}	22 N ^{2,39}	10 S ^{2,39,47}	1 ^{2,39}	UB UB	2,33,36,39,47	I	I	2,39	G	2,39
<i>Motacilla flava tschutschensis</i>	70 N ¹⁷	60 N ¹⁷	19 N ^{2,47}	10 S ^{2,36,47}	1 ⁵	UB UB	2,33,36,47	I	I	2,31,47	G	2,31
<i>Motacilla cinerea</i>	70 N ^{2,17}	30 N ²	47 N ²	10 S ^{2,17}	1 ⁵	WB UB	2,31,38	I	I	2	G	2,32,47
<i>Anthus richardi</i>	64 N ³³	25 N ^{17,33}	34 N ³³	6 N ^{33,47}	1 ³⁹	UB UB	2,31,33,39,47	I	I	31,33,39	G	31,39
<i>Anthus campestris</i> (1)	53 N ²	33 N ²	37 N ²	14 N ^{2,39}	1 ⁵	UB UB	2,33,39	I	IS	2,33,39	G	2,39
<i>Anthus godlewskii</i>	54 N ^{17,33}	29 N ^{17,33,36}	29 N ³⁹	8 N ^{17,39}	1 ⁵	UB UB	2,17,33,39	I	IS	39	G	39
<i>Anthus similis similis</i>	36 N ^{2,39}	28 N ^{2,39}	35 N ^{2,39}	20 N ^{2,39}	1 ²	UB UB	2,31,39	I	IF	2,39	G	2,39
<i>Anthus trivialis</i> (1)	65 N ^{2,33}	32 N ^{2,39}	32 N ^{2,39}	11 N ^{2,39}	1 ⁵	MB D	2,31,39	I	IS	2,39	G	2
<i>Anthus hodgsoni</i>	70 N ²	23 N ²	36 N ^{2,33}	4 N ⁴⁷	1 ^{2,5}	D WB	2,31,33,39	I	IS	2,39	G	2
<i>Anthus gustavi gustavi</i>	70 N ^{2,17}	51 N ^{2,17}	19 N ^{2,17,33}	10 S ^{2,30}	1 ²	MB D	2,17,33,36	I	I	2,31	G	2
<i>Anthus gustavi menzbieri</i>	45 N ^{2,33}	42 N ^{2,33}	38 N ³⁶	22 N ¹⁷	1 ²	MB D	2,17,33,36	I	I	2,31	G	2
<i>Anthus cervinus</i> (1)	74 N ²	51 N ²	34 N ^{2,31}	3 S ²	1 ^{2,5}	UB UB	2,17,31,39	I	I	2,39	G	2
<i>Anthus roseatus</i>	42 N ³⁹	26 N ³⁹	35 N ³⁹	20 N ^{31,39}	1 ^{5,39}	UB UB	17,31,36,39	IS	IS	31,39	G	31
<i>Anthus spinoletta</i> (1)	70 N ²	34 N ²	38 N ²	20 N ²	1 ⁵	UB UB	2,33,39	I	I	2,39	G	2
FRINGILLIDAE												
<i>Fringilla montifringilla</i>	70 N ^{2,9}	50 N ⁹	53 N ⁹	20 N ^{9,31}	1 ^{5,9}	WB WB	2,9,39	IS	S	2,9	G	9,39
<i>Carduelis spinus</i>	59 N ⁹	43 N ⁹	45 N ⁹	20 N ⁹	1 ^{5,9}	WB WB	9	IS	S	2,9	V	9
<i>Carpodacus erythrinus</i>	67 N ⁹	21 N ⁹	34 N ^{2,9}	8 N ^{2,9}	1 ^{5,9}	MB MB	2,9	IS	IS	2,9	VG	2
<i>Coccothraustes coccothraustes</i>	56 N ^{2,39}	41 N ^{2,39}	45 N ^{2,9}	20 N ⁹	2 ^{5,9}	WB WB	2,9,33,39	IS	S	2,9	VG	9
<i>Eophonia migratoria</i>	54 N ⁹	25 N ⁹	37 N ⁹	20 N ⁹	2 ^{5,9}	WB WB	9	S	S	9	VG	9
<i>Eophonia personata</i>	54 N ⁹	40 N ⁹	26 N ⁹	22 N ⁹	2 ^{5,9}	WB UB	9	IS	S	9	V	.
<i>Emberiza stewarti</i>	45 N ⁷	30 N ^{7,39}	37 N ^{7,39}	21 N ^{7,39}	1 ⁵	D MB	7,39	IS	S	7,39	G	7,39
<i>Emberiza buchanani</i>	50 N ^{7,39}	30 N ^{7,39}	37 N ⁷	14 N ^{7,39}	1 ^{5,39}	UB UB	2,7,39	I	S	2,7	G	2,39
<i>Emberiza tristrami</i>	50 N ⁷	41 N ⁷	31 N ⁷	20 N ⁷	1 ⁵	WB WB	7	IS	IS	7	VG	.
<i>Emberiza fucata</i>	48 N ^{7,36}	35 N ⁷	36 N ⁷	16 N ^{7,39}	1 ⁵	MB MB	7,39	IS	IS	7,39	G	39

<i>Emberiza pusilla</i>	73 N ⁷	56 N ⁷	34 N ⁷	18 N ⁷	1 ^{5,39}	D MB ^{7,39}	I IS ^{7,39}	G ³⁹
<i>Emberiza chrysophrys</i>	64 N ⁷	52 N ⁷	32 N ⁷	22 N ⁷	1 ⁵	WB MB ⁷	I S ⁷	- -
<i>Emberiza rustica</i>	70 N ⁷	50 N ⁷	43 N ^{2,7}	22 N ^{2,7}	1 ^{2,5}	WB D ^{2,7}	I S ^{2,7}	VG ²
<i>Emberiza elegans</i>	52 N ⁷	34 N ⁷	44 N ⁷	22 N ⁷	- -	WB WB ^{7,31,38}	- - -	- -
<i>Emberiza aureola</i>	70 N ⁷	40 N ⁷	29 N ⁷	9 N ⁷	1 ^{2,5}	MB UB ^{2,7}	I S ^{2,7}	G ²
<i>Emberiza rutila</i>	64 N ⁷	48 N ⁷	27 N ⁷	10 N ⁷	1 ⁵	WB MB ⁷	I S ⁷	G ^{7,39}
<i>Emberiza bruniceps</i>	51 N ⁷	30 N ⁷	32 N ⁷	12 N ^{7,39}	1 ⁵	UB UB ^{2,7,39}	I S ^{2,7}	G ²
<i>Emberiza sulphurata</i>	42 N ⁷	35 N ⁷	25 N ⁷	14 N ⁷	- -	WB MB ^{7,38,40}	- - -	- -
<i>Emberiza spodocephala</i>	65 N ⁷	26 N ⁷	36 N ⁷	18 N ^{7,39}	1 ⁵	WB MB ^{7,38}	I S ⁷	G ³⁸
<i>Emberiza schoeniclus schoeniclus</i>	73 N ⁷	42 N ⁷	47 N ⁷	21 N ^{7,17}	1 ^{2,5}	MB UB ^{2,7}	I IS ⁷	G ²
<i>Emberiza pallasi pallasi</i>	70 N ⁷	56 N ⁷	44 N ⁷	24 N ^{7,17}	1 ⁵	D MB ^{2,7}	I IS ^{2,7}	- -
REGULIDAE								
<i>Regulus regulus</i>	55 N ⁴²	35 N ⁴²	42 N ⁴²	22 N ⁴²	1 ^{5,42}	WB WB ⁴²	I I ⁴²	V ^{2,42,49}
CISTICOLIDAE								
<i>Cisticola juncidis</i>	34 N ^{36,42}	21 N ⁴²	28 N ^{36,42}	21 N ^{36,42}	1 ⁵	UB UB ^{36,42}	I I ⁴²	V [*]

* K.D. Bishop in litt.

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|----|----------------------------------|----|-------------------------------------|----|-------------------------------|----|---------------------------------|
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| 2 | Cramp 1985-1992 | 15 | National Geographic Society 1983 | 31 | Robson 2000 | 47 | MacKinnon & Phillipps 1994 |
| | Cramp & Perrins 1993-1994 | 16 | Kaufman 1996 | 32 | MacKinnon & Phillipps 2000 | 48 | King <i>et al.</i> 1975 |
| | Cramp & Simmons 1977-1983 | 17 | Sibley & Monroe 1990 | 33 | Dement'ev & Gladkov 1966-1968 | 49 | Roberts 1992 |
| 3 | Fry <i>et al.</i> 1992 | 18 | Raffaele <i>et al.</i> 1998 | 34 | Harrison <i>et al.</i> 1997 | 50 | Wild Bird Society of Japan 1983 |
| 4 | Fry <i>et al.</i> 1986-1997 | 19 | König <i>et al.</i> 1999 | 35 | Clement & Hathway 2000 | 51 | Bates & Lowther 1952 |
| 5 | Dunning 1993 | 20 | Curson <i>et al.</i> 1994 | 36 | De Schauensee 1984 | 52 | Johnsgard 1978 |
| 6 | Chantler & Driessens 1995 | 21 | Ridgely & Tudor 1989 | 37 | Blakers <i>et al.</i> 1984 | 53 | Johnsgard 1983 |
| 7 | Byers <i>et al.</i> 1995 | 22 | American Ornithologists' Union 1983 | 38 | Brazil 1991 | 54 | Hayman <i>et al.</i> 1986 |
| 8 | Turner & Rose 1989 | 23 | Rising 1996 | 39 | Ali & Ripley 1969-1996 | 55 | Johnsgard 1988 |
| 9 | Clement <i>et al.</i> 1993 | 24 | Johnsgard 1997 | 40 | Birdlife International 2000 | 56 | Hancock & Kushlan 1984 |
| 10 | LeFranc & Worfolk 1997 | 25 | Winkler <i>et al.</i> 1995 | 41 | Feare & Craig 1998 | 57 | Peterson & Chalif 1973 |
| 11 | Sibley 2000 | 26 | Cleere & Nurney 1998 | 42 | Baker 1997 | 58 | Ali 1979 |
| 12 | Brown & Amadon 1968 | 27 | De Schauensee 1970 | 43 | Shirihai <i>et al.</i> 2001 | 59 | Gibbs <i>et al.</i> 2001 |
| 13 | Ferguson-Lees & Christie 2001 | 28 | Ehrlich <i>et al.</i> 1988 | 44 | Taylor & van Perlo 1998 | 60 | Wells 1999 |
| | | 29 | Jeyarajasingam & Pearson 1999 | 45 | Kennedy <i>et al.</i> 2000 | | |