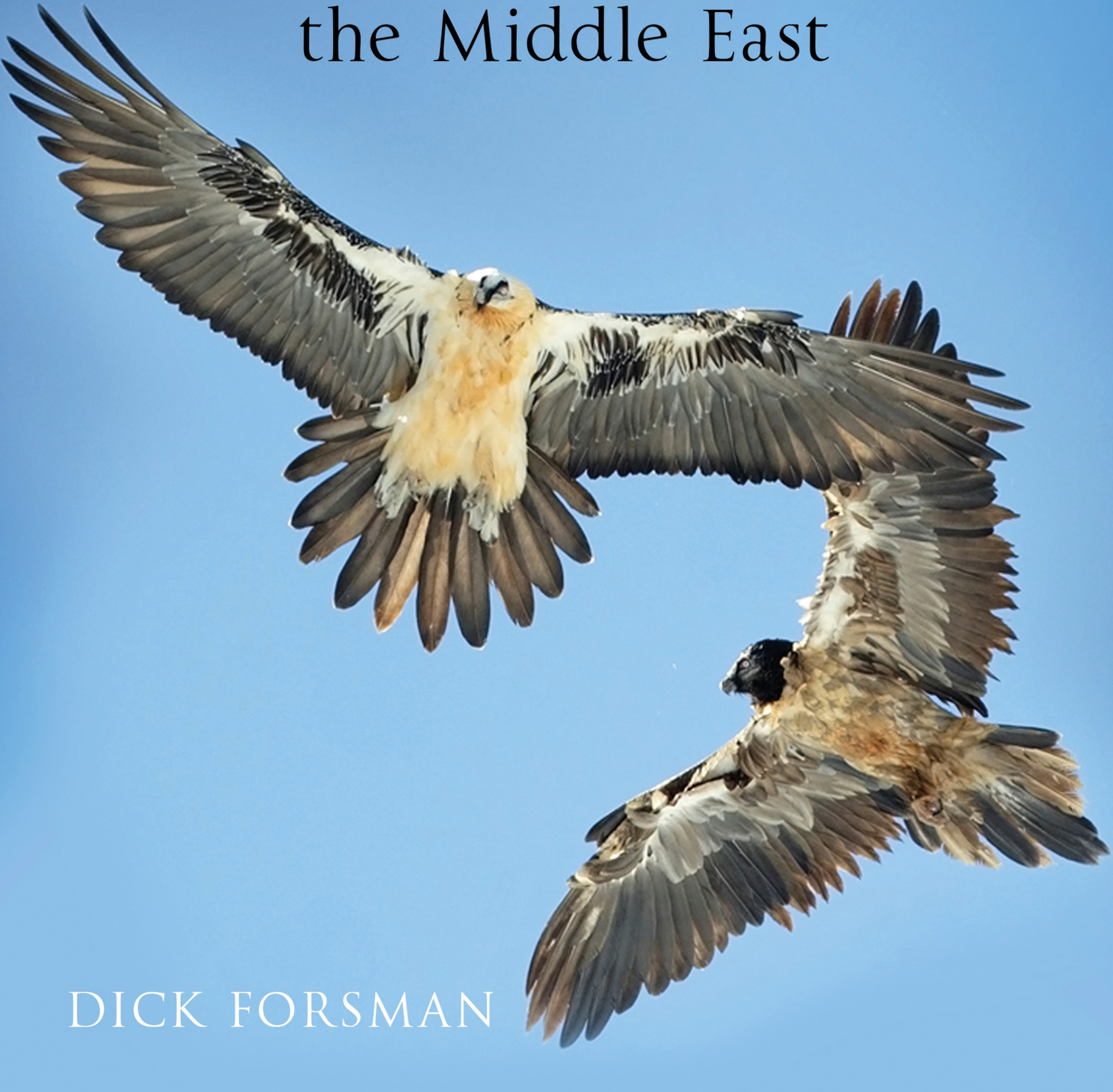
FLIGHT IDENTIFICATION OF RAPTORS

of Europe, North Africa and the Middle East



DICK FORSMAN

BLOOMSBURY

FLIGHT IDENTIFICATION OF
RAPTORS
OF EUROPE, NORTH AFRICA AND THE MIDDLE EAST

HELM IDENTIFICATION GUIDES

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RAPTORS
OF EUROPE, NORTH AFRICA AND THE MIDDLE EAST

Dick Forsman

FUNDACIÓN
MIGRES

CHRISTOPHER HELM
LONDON

All the images taken by the author are of wild, free-living birds of prey.

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FUNDACIÓN
MIGRES

Migres Foundation is a private non-profit organisation founded in 2003 to promote scientific research on bird migration and to boost sustainable development activities. We are convinced that these policies offer the best tools for biodiversity conservation.

Moreover, Migres Foundation has become a necessary association which reconciles sustainable development and biodiversity conservation, providing solutions for environmental challenges which, if conveniently tackled, become true opportunities of economic and social sustainable growth.

The relationship between Migres Foundation and the Tarifa Wind Power Association has provided the necessary resources for the publication of this guide, which forms part of the suite of environmental measures designed by Migres Foundation to mitigate the impact of wind farms around Tarifa. This book will enhance wildlife conservation through the dissemination of knowledge and research. The Tarifa Wind Power Association was founded in 2000 to coordinate the efforts of their associates in promoting their projects.

ASOCIACIÓNEÓLICATARIFA

PREFACE

Although focusing on flight identification only, this new book draws strongly on its predecessor *The Raptors of Europe and the Middle East: A Handbook of Field Identification*, which still stands its ground after all these years and contains much useful information not found in this book. In particular, the introductory chapters are well worth reading and are not repeated here. Nevertheless, since its first publication in October 1998, there was always a plan to publish a more user-friendly edition, with a clear focus on flight identification, and this book now fulfils this aim.

With the breakthrough of digital photography in the early 2000s, everything changed. Never before has bird photography been so easy. Suddenly there was a need to capture all the raptors again with the latest digital equipment. Since 2003 my goal has been to find and to document all the raptor species found within the Western Palearctic, capturing their different plumages for this book. This quest has taken me on scores of trips abroad, with more than 60 tours to Spain, Israel and Arabia alone, and additional ventures to other far-flung corners of the Palearctic and African regions.

This book focuses on the identification of flying birds for a reason. Identifying raptors perched and in flight are two completely different games, and the characters and methods used for each are rarely the same. Since raptors are mostly seen in flight, it feels natural that their flight identification is what needs to be addressed.

This book relies strongly on its photographs. They have been chosen to show the different plumages but also to give an idea of known plumage variation. Most identification challenges could probably be dealt with by just consulting the images and their captions, the main text being there as a back-up reference for more difficult situations.

Raptors will still be tough to identify even after the publication of this book. Their geographic forms, complex taxonomy and bewildering plumage variation will see to that. With this in mind, it is important to understand that no book can ever replace time spent in the field. There is no substitute for personal field experience!

Juvenile Steppe Eagle. Oman, 6.11.2004 (DF)

A flock of soaring Steppe Buzzards on spring migration over Eilat, Israel. 28.3.2008 (DF)

ACKNOWLEDGEMENTS

A book like this would not be possible to produce without help from others. During my travels I have met a lot of people with whom to discuss the various points of raptor identification. Some of the acquaintances were brief, while others led to a long and lasting friendship. Nevertheless, they all contributed to this book in one way or another. I extend a collective thank you to everybody for crossing paths with me.

Some people have played a major role and must be specifically acknowledged. Mark Constantine and The Sound Approach must be thanked for constant support and encouragement during the entire project. I am most grateful to Fundación Migres, in particular Miguel Ferrer, Antonio-Roman Muñoz, Eva Casado and Luis Barrios, for their cooperation and for granting financial support for my work.

I am also sincerely grateful to two of the biggest names in raptor research, Ian Newton and Keith Bildstein, for participating in this publication with their instructive and authoritative articles on raptor migration.

The following persons have helped me in various ways; some by joining me in the field, others by providing hints regarding literature, contacts and accommodation, or by providing help in some other way. I am greatly indebted to all of you; it has been a great pleasure knowing you: Dan Alon, Janos Bagyura, Arnoud van den Berg, Patrick Bergier, Stavros Christodoulides, José Luis Copete, Paul Dernjatin, Gerald Driessens, Marc Duquet, Javier Elorriaga, Hanne and Jens Eriksen, David Erterius, Wouter Faveyts, Waheed al Faziri, Juan Antonio “Kiko” Gil, Sundev Gombobaatar, Miguel Gonzales, Barak Granit, Tom Gullick, José “Pepe” Guzman, Thomas Hadjikyriakou, Teppo Helo, Vesa Hyyryläinen, Pentti Kallio, Igor Karyakin, Aleksei Koshkin, Aleksi Lehikoinen, Petteri Lehikoinen, James Lidster, Jan Lontkowski, Dani Lopez Velasco, Patricia Maldonado, Björn Malmhagen, Jonathan Meyrav, Jozef Mihók, Istvan Moldovan, John Muddeman, Killian Mullarney, Antonio-Roman Muñoz, Alejandro Onrubia, Gerald Oreel, Carlos Pacheco, Vanesa Palacios, Clairie Papazoglou, Vittorio Pedrocchi, Jari Peltomäki, Yoav Perlman, Kostas Pistolas, René Pop, Pekka Pouttu, Mátyás Prommer, Colin Richardson, Magnus Robb, Josele Saíz, Yeray Seminario, Itai Shanni, Kari Soilevaara, Matti Suopajärvi, Magnus Ullman, Ülo Väli, Machiel Valkenburg, Aarne Vattulainen and Pim Wolf. Please forgive me if I have inadvertently omitted any names from this list.

I am grateful to Dale Forbes of Swarovski Optik and to Hans Dahlgren of Swarovski Optik Nordic for their support in obtaining appropriate field optics. A sincere thank you must also go to all my clients who have travelled with me over the years – thanks for your patience when I left you standing to chase after yet another raptor. A special thank you must also go to all the photographers who participated and kindly let me use their material for the book: Ralph Buij, Richard Crossley, Peter Csonka, Javier Elorriaga, Jaakko Esama, Stewart Finlayson, Annika Forsten, Hannu Huhtinen, Johann Knobel, James Lidster, Jerry Liguori, Tom Lindroos, Bruce Mactavish, Rishad Naoroji, Gabor Papp, René Pop, Janne Riihimäki, Markku Saarinen, Yeray Seminario, Martti Siponen, Ülo Väli and Brian K Wheeler.

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Finally, I must thank all those hundreds of people who over the years have been in touch with me, either in the field or through letters and emails, usually asking for help with the identification of particular birds. I have learnt a lot from those contacts, but I hope the gain has been mutual. Thank you.

A cocktail of eagles: juvenile Greater Spotted top two, subadult Steppe Eagle in the middle and adult Eastern Imperial Eagle bottom.
Oman, 12.12.2012 (DF)

INTRODUCTION

FLIGHT IDENTIFICATION OF RAPTORS

Identifying raptors in flight can feel like a daunting task for the beginner; the species are many, the variation is often overwhelming, depending on age, sex or just individual variation, and the viewing conditions may vary from one extreme to the other, depending on distance and light. To identify a close-flying raptor one needs to deploy a different set of characters compared to identifying the same bird from a distance, when only major feather tracts rather than plumage details are visible. The approach of this book is to show the birds at close range, showing the necessary details needed for a positive identification. Once you are familiar with the details they can always be converted to be used on more distant birds.

PLUMAGE VARIATION IN RAPTORS

Raptors as a group are notoriously variable. Just think of the European Honey-buzzard as a species, with endless individual variation in every age-class and on top of this the difference between the sexes in the adults. The variation may appear bewildering, but focusing on the right feather tracts can help a lot. In the case of the honey-buzzard one can ignore the variable body plumage completely and focus on the less variable pattern of the flight feathers, and suddenly it all becomes much easier: juveniles are easily separated from the adults, and adult males and females are equally easy to tell apart. The same applies to a lot of raptor species: if the markings of the underwing flight feathers can be made out reasonably well, the species can usually be identified with certainty by this single character alone. Also, the geographical variation can be considerable, not only between subspecies of different geographical origin, but also within one subspecies. For instance, the nominate subspecies of the Common Buzzard has several subpopulations in Europe which differ in size and average coloration, yet they are all considered to belong to the same subspecies.

VIEWING CONDITIONS

The viewing conditions have a great effect on how we perceive a bird, ambient light being the single most important factor of all. The impression of a bird will change dramatically depending on the quality and direction of the light. Even reflected light, or the lack of it, can add a dimension, which sometimes can feel puzzling. To take an example, a Common Buzzard against a blue sky will show some plumage details, but as it drifts against a light cloud it suddenly changes to a featureless black silhouette. If it is circling above a landscape covered in snow, or even light-coloured sand, its colours appear almost surreal, because of the intense light bouncing off the ground. Conversely, if the bird flies over a green forest or a green field it will look dark, as very little light is reflected from these surfaces. It is also important to realise that the quality of light changes during the course of the day. Around noon, when the sun is at its highest in the sky, more light is reflected onto the underparts of a bird from the ground, while the same bird will look dark underneath in the morning and afternoon because of the low angle of the sun, when light is no longer reflected upwards.

The images for this book have been chosen to show the various identification features as clearly as possible. Many of the selected images have been taken in special light conditions, with snow or sand reflecting light onto the underparts. Conditions may not always be as favourable as shown, but the intention has been to show as much detail of the bird as possible, knowing that the light in most field situations is less favourable. To get a more life-like feeling of the images one can hold out the book at an arm’s length or look at the images while squinting your eyes; both methods help to give a better idea of the bird in the field.

Figure 1. Adult female Eurasian Hobby photographed one hour after sunrise. Although the head and body catch the direct morning sun the underwings and tail remain dark due to lack of reflected light. In similar lighting conditions Eurasian Hobbies could easily be mistaken for an Eleonora's Falcon, and adults of Steppe or Lesser Spotted Eagles may look practically identical to an adult Greater Spotted Eagle, and so on. Finland, 5.8.2015 (DF)

MOULT

Moult is the single phenomenon responsible for the greatest changes in a bird's appearance. As a nestling every raptor grows its first full set of feathers, the juvenile plumage, which, as a rule, is carried for approximately the first year of life. Since all feathers have been grown at the same time this plumage appears very uniform, in terms of its condition. Soon after the breeding season it is fresh, often with clearly visible lighter tips and margins to each feather. During the first year it gradually wears and fades, but is still rather uniform in appearance. There are, however, exceptions to this general rule. Some small species, mostly long-distance migrant species of falcons and harriers, have a partial body moult in their first winter, resulting in a transitional plumage comprising both juvenile and new, moulted feathers. The main rule is that if a raptor is moulting its flight feathers in late summer/autumn, it cannot be a juvenile, but is at least one year old.

After about one year from fledging the first complete moult starts and the entire plumage is moulted, but both the extent and the timing of moult vary from species to species, sometimes even between populations of the same species. Most small and medium-sized resident or short-distance migrant species

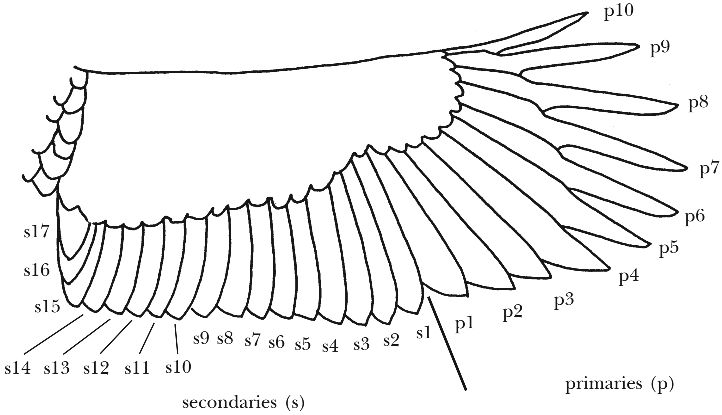


Figure 2. Wing of juvenile White-tailed Eagle showing the numbering of the remiges.

covered by this book moult during the breeding season, replacing the entire plumage in one moult cycle. The long-distance migrants, wintering in sub-Saharan Africa, may or may not commence their moult while still on the breeding grounds, but most of the moulting takes place on the wintering grounds in Africa.

The large eagles and vultures have a different moulting strategy. Because of their long flight feathers and the rather slow feather growth they are not capable of replacing the entire set of flight feathers in one season. In order to retain their flying ability they moult just a part of their plumage in a season, and the process of replacing the entire juvenile plumage takes several years. Knowing the moulting strategy, and the timing and extent of each moult, immatures of these large species can be aged by the number of retained juvenile feathers in the wing, for some species up to the age of 3–4 years. As these large raptors get older they gradually develop a stepwise moult, in which neighbouring sections of flight fathers are moulted simultaneously, thus reducing the time needed to complete a moult cycle. The stepwise moult also explains why adult eagles and vultures appear to have a comparatively fresh-looking plumage, rarely showing the very faded and worn flight feathers that are so commonly seen in immatures of the same species.

Moult can also have implications on species identification. Several closely related species can be safely identified by the wing-formula (the relation between the tips of the longest primaries forming the wingtip), which is species-specific, often used for separating species pairs or groups like Common and Lesser Kestrels, Shikra and Levant and Eurasian Sparrowhawks, Hen and Pallid/Montagu's Harriers, and so on. However, as the primary moult reaches the long primaries, missing and growing feathers will make this character useless. A moulting Hen Harrier in Aug–Sep may show a wingtip reminiscent of a Pallid/Montagu's and a Eurasian Sparrowhawk will at the same time have a wingtip which may recall a Shikra or a Levant Sparrowhawk, and so on.

Since the onset of moult in most raptor species is so strictly linked to the breeding season, different populations can sometimes be told apart just by checking the status of moult. In Ospreys, birds breeding in Arabia and the Red Sea start to breed around New Year, while Scandinavian migrants begin their breeding season some 4–5 months later. The different breeding season is then reflected in the start of the wing-moult in juveniles, with southern birds dropping their innermost primary some four months prior to their migratory relatives from the north. A similar situation is also found in Peregrines, where

Figure 3. Male Montagu's Harrier in a late 2nd cy summer transitional plumage, illustrating the progress of the flight feather moult in an *Accipitridae* hawk. In the primaries p1–p6 have been replaced by adult-type feathers and p7 is more than half-grown, while p8–p10 are retained juvenile feathers. In the secondaries only s1, s5 (with a black band) and the innermost s11 have been moulted, all others being retained juvenile feathers. Although p7 is growing the bird has suspended its moult and is not actively moulting; the remaining juvenile feathers will be replaced on the wintering grounds. Spain, 3.9.2013 (DF)

resident birds from the Mediterranean complete their complete flight feather moult by late October, while their migratory relatives from the far north are not even halfway through with theirs.

Moult in hawks and eagles *Accipitridae*

The primary moult in hawks and eagles follows a simple basic pattern, where the primaries are shed in a sequence starting with the innermost p1 and finishing with the outermost p10. In most species with a normal complete annual moult the replacement of primaries starts at the onset of breeding, in females usually at the time of laying, in males up to several weeks later. The entire moulting process of the flight feathers starts with the dropping of p1 and only after this does the moult of the secondaries and tail commence.

The secondary moult is simultaneously active at several different points, but usually starts with the dropping of either s1 or s5, quickly followed by the other, and from these foci the moult progresses inwards, towards the body. Soon after the activation of the foci at s1 and s5, a third focus is also activated at the innermost secondary, from where the moult progresses outwards, away from the body. Towards the end of the moult cycle the waves that started at s5 and s11, moving in opposite directions, will meet halfway along, usually around s8–s9, which is the place to look for the last remaining old feathers. Sometimes these secondaries are left unmoulted and may offer important clues for ageing, particularly in the case of retained juvenile feathers.

The basic pattern explained above applies to the smaller species, such as accipiters and harriers, while larger species have developed a more complex strategy. *Buteo* buzzards, for instance, regularly do not complete their first moult, but retain some outer juvenile primaries and keep them until their second moult in their 3rd cy summer. When the second moult commences these outer primaries are shed simultaneously with the inner primaries of a new moult cycle, starting from the innermost primary p1. This creates a seemingly irregular pattern, with two simultaneous moult fronts chasing each other

Figure 4. Older immature Eastern Imperial Eagle clearly showing the stepwise moult typical of older immatures and adults of larger eagles and vultures. Note how waves of freshly moulted (dark) feathers are chasing each other, separated by more worn (lighter) feathers in between. In this particular case the difference between the new and old feathers is emphasised by the fact that the older feathers are of the lighter immature type, while the more recently replaced feathers are of the darker adult type. Since new moult waves start from the active points (foci) before previous waves have been completed, several parallel moult fronts are active at the same time, enabling the bird to moult a greater number of feathers per moult cycle compared to a simpler moult strategy with just one front active at a time. Oman, 7.12.2010 (DF)

in the primaries. These follow the bird through life and older *Buteo* buzzards regularly show two or three simultaneous moult fronts in the primaries. This kind of moult is known as stepwise moult, and is typical of all larger raptors.

With age all large eagles and vultures develop a stepwise moult, but the details vary depending on the size of the bird, but also depending on the species' ecology and migration habits. Most of these large species only replace a few inner primaries in their first moult, while the rest of the plumage remains juvenile. In the next moult the following year the primary moult is resumed where it stopped the year before, but again only a few flight feathers are replaced and many of the outer primaries are still juvenile feathers. During the second moult many species start to moult their inner primaries again, for a second time, thus showing two simultaneous moult fronts in the primaries. As the first and second waves gradually progress towards the outer primaries additional new waves are activated at p1, eventually resulting in several simultaneously active moult fronts in the primaries. Birds following the above strategy include all large species of eagle and vulture, while the smaller spotted eagles and Egyptian Vulture are capable of replacing more feathers per moult cycle, partly because they also moult extensively in the winter quarters and are thus more similar in this respect to the *Buteo* buzzards.

Moult in falcons *Falconidae*

The flight feather moult in falcons differs greatly from the moult described above for hawks and eagles. The primary moult starts by dropping one of the median primaries, usually p4 (sometimes p5), after which the moult progresses both ways, one wave proceeding towards the wingtip and the other towards the innerwing. Halfway through the moult the primaries show a block of fresh median feathers flanked by worn inner and outer primaries. The last primaries to be shed are p1 and p10, and usually the latter terminates the wing moult, being the last feather to reach its full length.

Figure 5. This female Lesser Kestrel, captured at an early stage of its primary moult, has dropped pp3–6 (pp4–6 on the left wing) in rapid succession, and also s5. The dark tip of a new p5 can already be seen in both wings, while p4 and p6 are still in pin. Spain, 30.6.2015 (DF)

The secondary moult starts with s5 (sometimes s4) from where the moult proceeds both ways, outwards and inwards. After a while another moult wave starts from s11 and proceeds outwards, eventually meeting the wave from s5 somewhere in the middle. The innermost two secondaries, or the tertials, are moulted separately during the course of the secondary moult. The last secondary to be replaced is usually the outermost, s1. Occasionally the odd median secondary may be retained after moult is completed, but this happens more rarely in falcons compared to hawks of a similar size.

Resident and short-distance migrant species, like Gyr Falcon, Common Kestrel and Merlin, and also resident populations of Peregrine, complete their flight feather moult in one go, except perhaps for a short temporary break during breeding, while long-distance migrants such as Eurasian Hobby, Sooty and Eleonora's Falcons, and Red-footed and Amur Falcons only moult a few or no remiges at all while breeding, as most of the moult is undertaken on the wintering grounds.

FACTORS AFFECTING FLIGHT

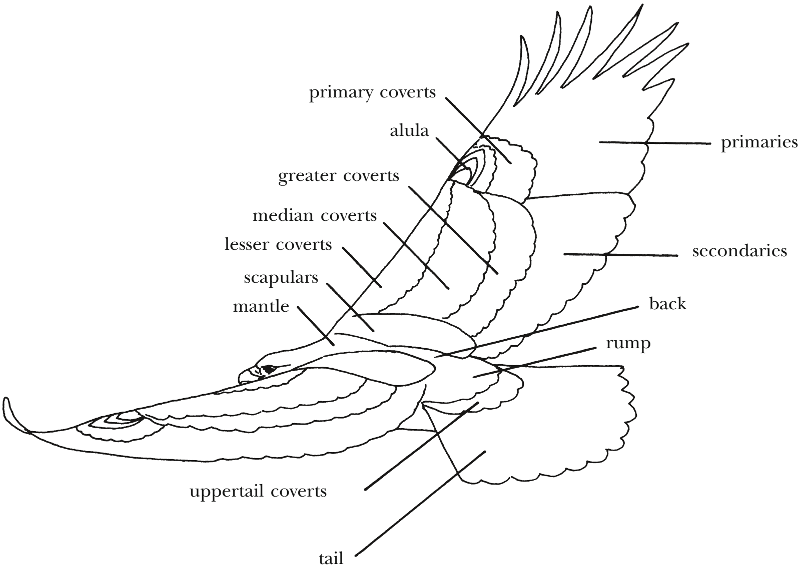
Although many species can be identified, with experience, by the way they fly or move through the air there are several factors affecting the flight, which need to be taken into account.

Moult is one factor, which may considerably change the way a bird flies. Missing feathers have a direct impact on the bird's wing-loading (the relation between the bird's weight and its wing area), by hampering the carrying capacity of the wings. Moult does not only affect the bird's flight, it also alters the silhouette and may in some cases change the look of a bird to remind one of another species. Wind conditions are also of importance to how we perceive the flight of a bird. Strong or light winds, and head- or tail-winds all have a bearing on the flight. Raptors can sometimes be seen carrying prey, which also affects the wing-loading and hence the normal flight. Even a full crop may change the flight of a bird, as the point of gravity is shifted forward and to counterbalance itself the bird has to push its wings further forward. This is particularly obvious in large vultures, in which a full crop also extends their necks, changing the entire flight silhouette. Also, the purpose of the flight makes a huge difference to the wing-action and the behaviour of the bird. Raptors can be soaring, gliding, flapping, stooping, hovering, and so on, not to mention various sorts of flight displays and mutual interactions. With some experience it is easy to see different modes, even of the normal powered flapping flight depending on the situation. The normal powered flight on migration is more relaxed than the very determined and purposeful wing-action of a bird taking up a chase after prey or fending off an intruder from its territory.

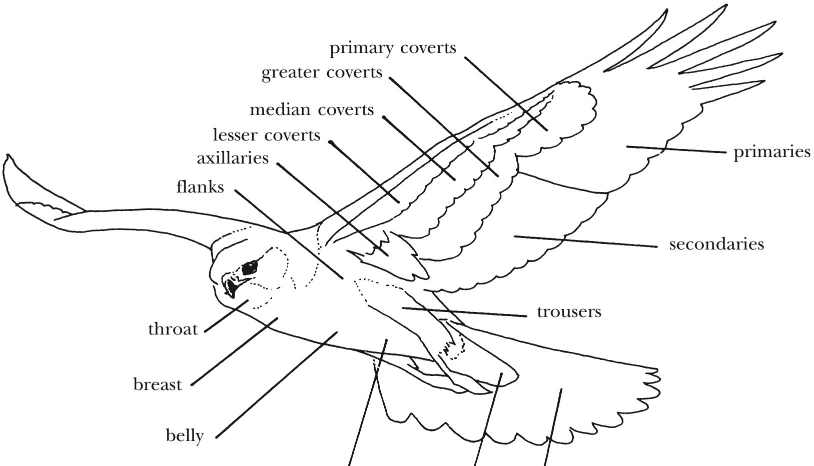
PREVIOUS EXPERIENCE

When it comes to identifying raptors, the simple truth is that there is no substitute for experience. The more you see and the more often you see the same birds over and over again, the more confident you will get. Books are good for checking plumage details, but other important clues, like learning the different flight modes, the ever varying silhouettes, and tricks of light and wind, can only be learnt through repeated and careful observation. Start with whichever species is the commonest around you and never miss an opportunity to look and learn, over and over again. Once you know the common birds any vagrant will stand out and set the alarm bells ringing.

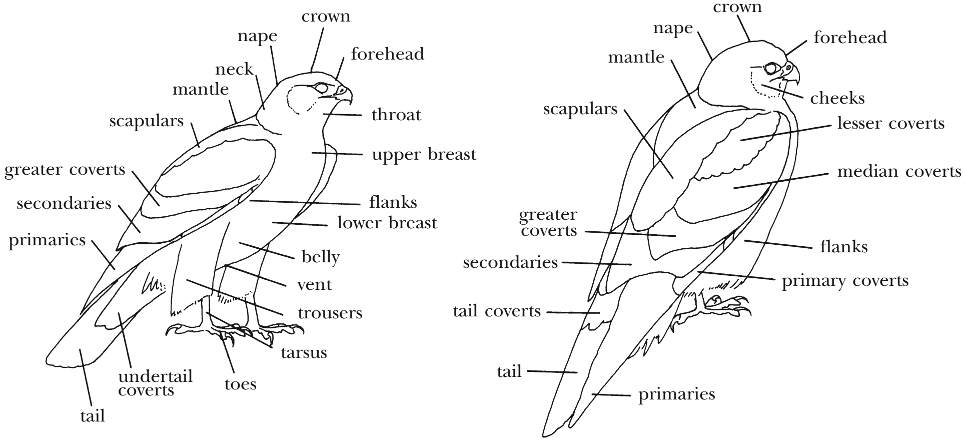
TOPOGRAPHY



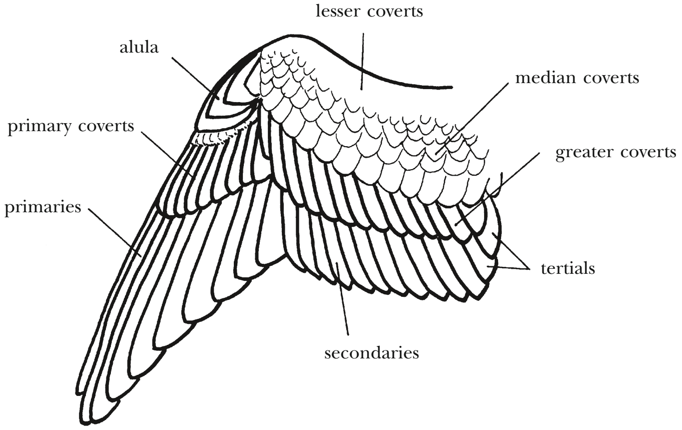
Feather tracts of upperparts in flight



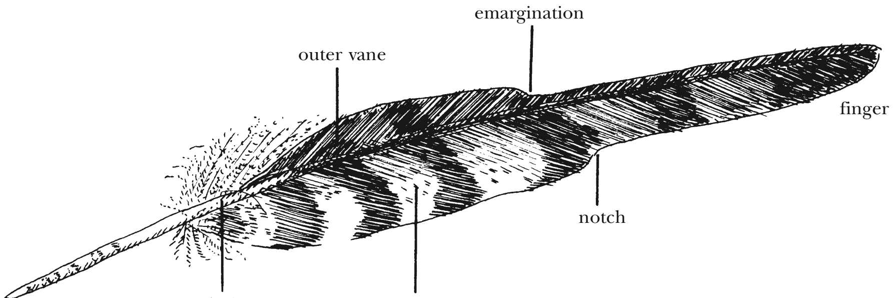
Feather tracts of underparts in flight



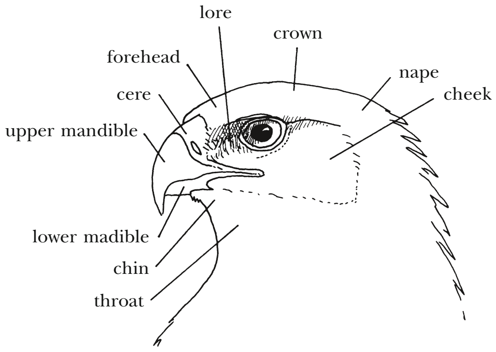
Feather tracts of a perched bird



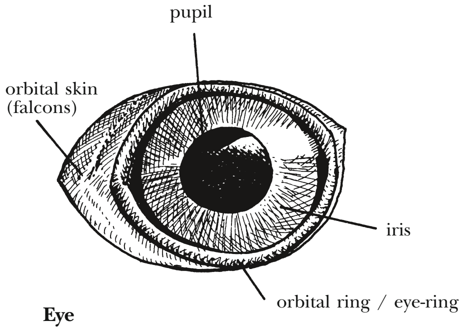
Upperwing



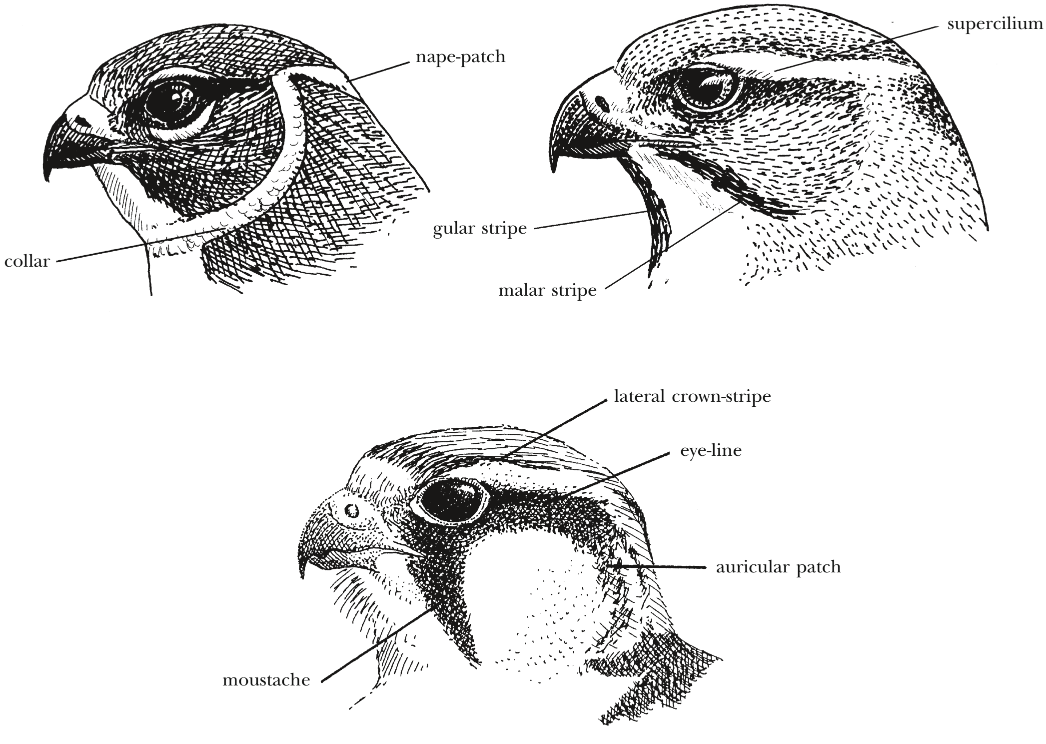
A fingered primary



Head



Eye



Head markings

GLOSSARY

Adult (ad; plumage) The final plumage of a bird.

Anterior Towards the front or the head of the bird.

Ascendant moult (moulting sequence) When the moult wave in the wing progresses towards the body (away from the wingtip).

Auricular (spot or patch) Plumage mark on the ear coverts, sometimes also including part of the cheeks.

Axillaries The elongated feathers of the 'armpit'.

Bare parts The parts of a bird not covered with feathers (usually cere, bill, eyes, eye-rings and feet).

Body plumage All contour feathers of a bird, excluding the remiges and the rectrices.

Carpal (carpal-patch, -area, -comma, etc.**)** The underwing primary coverts or the area close to it.

Centre (moult centre) The position from where the moult of the flight feathers starts (cf. Focus).

Cere The unfeathered, waxy skin covering the base of the upper mandible in birds of prey.

Cheek The side of the head below the eye.

Collar Specially shaped feathers surrounding the facial disk of harriers *Circus*.

Contour feather All (visible) feathers covering the bird, as opposed to down.

cy (calendar year) A bird is in its 1st cy from its birth until 31st December of that same year, when overnight it becomes 2nd cy, and so on. The 'birthday' is thus on 1st January every year.

Descendant moult (moulting sequence) When a moult wave progresses away from the body (towards the wingtip).

Definitive adult The final adult plumage of a bird which will not change further with age. The term 'full adult' is often used for this final plumage stage.

Dihedral Wing position of a bird in flight, with wings held above the horizontal plane in a shallow V.

Dimorphic A bird showing two distinct (colour) morphs.

Distal Towards the periphery; away from the bird's body; opposite of Proximal.

Divergent moult Wing-moult starting from a focus but progressing simultaneously inwards and outwards; typical of remex-moult in falcons.

Dorsal The upper surface (upperparts) of a bird; opposite of Ventral.

Eye-line Usually a dark line in front of and/or behind the eye.

Eye-ring The bare skin around the eye; rather prominent in falcons *Falco*, for example.

Feather tract A set of feathers that grow and wear together, and are moulted at roughly the same time.

Fingers The emarginated tips of the longest primaries.

First-adult plumage In many medium-sized raptors a first-adult plumage can be separated from the definitive adult plumage at close range.

First-summer plumage The plumage worn during the 2nd cy summer, at an age of *c.* one year; this is usually a mix of juvenile and adult feathers.

Flight feathers The remiges and retrices.

Focus (plural **foci)** The point where a moult wave starts, indicating the first feather to be shed in a given sequence.

Gular stripe A longitudinal streak on the throat.

Immature (imm; plumage) In this book given the meaning ‘not mature’ or ‘non-adult’ and includes all the plumages except for the adult plumage (also the juvenile if not specified more exactly).

Juvenile A young bird in its first year of life, still carrying its juvenile remiges.

Juvenile plumage (juv; plumage) The first complete plumage acquired in the nest and during the fledging stage. Most raptor species have this plumage until their first complete moult in the 2nd cy spring, but some (smaller) species undergo a partial moult of the body feathers during the first winter.

Leading edge of wing The anterior edge of the wing.

Lores The area between the eyes and the cere. Usually covered in bristles, but in honey-buzzards covered in scale-like feathers.

Malar stripe Usually a dark stripe running from the gape along the lower edge of the cheeks.

Mantle The feather tract between and in front of the scapulars, sometimes also given the meaning of the upperparts more generally, including the scapulars.

Monotypic Species with only one (the nominate) subspecies.

Morph A distinct (plumage) variant of a species.

Moustache A prominent dark mark below the eye, especially in falcons.

Nape The upper hindneck, to the rear of the crown.

p = primary (pp = primaries) Used for numbering the primary flight feathers: p1, p2 etc; numbered descendantly from the innermost to the outermost.

Patagium The fold of skin between the wrist and the body (which equates to the forearm).

Phase An age-related colour form of a species, often incorrectly applied to Morph.

Plumage All the feathers a bird has at any one time.

Plumage-type Indicates a separable, age-linked plumage, although exact ageing may not be possible.

Polymorphic A species with two or more distinct morphs, usually differing in colour.

Polytypic A species with two or more subspecies (cf. Monotypic).

Posterior Towards the rear end of the bird.

Primaries The outer flight feathers of the wing attached to the metacarpus and digits, forming the ‘hand’.

Primary projection The tips of the primaries that project beyond the tertials on a closed wing.

Proximal Towards the base of a structure (tail, feather, etc.); opposite to Distal.

Rectrix (plural **Rectrices)** Tail feather(s).

Remex (plural **Remiges)** Wing feather(s), used for the primaries and secondaries together.

Ruff The elongated neck feathers in some vultures.

s = secondary (ss = secondaries) Used for numbering secondary flight feathers: s1, s2 etc; numbered ascendantly, from the outermost to the innermost.

Scapulars Dorsal feathers on each side of the mantle, covering most of the upperparts on a perched bird.

Secondaries The inner flight feathers of the wing, attached to the ulna (and humerus), forming the ‘arm’.

Serially descendant moult When a second moult starts before the first has finished, resulting in two (or three) active moult centres in a wing.

Sp. Species (plural **spp**.).

Ssp. Subspecies.

Subadult (subad; plumage) The plumage(s) preceding the adult plumage.

Subterminal band (on feather) A dark band just inside the tip of a feather.

Supercilium A contrasting (usually pale) line running above the eye.

Suspended moult When the moult is interrupted e.g. for migration or during breeding, but resumed shortly after.

Terminal band (on feather) A band at the tip of a feather.

Tertials The innermost secondaries, varying in number between two and three in raptors.

Trailing edge The posterior edge of the wing, formed by the tips of the secondaries and inner primaries.

Trousers The elongated feathers of the thighs.

Underbody/underparts The feathering of the underside of the body and the underwing-coverts.

Underwing The lower surface of the wing.

Upperparts The feathering of the entire upperside including body, wings and tail.

Upperwing The upper surface of the wing.

Ventral The underparts or lower surface of the bird or a structure; opposite to Dorsal.

Wing-formula The relative distances between the primary tips forming the wingtip; mostly compared with the tip of the longest primary.

Wingspan The measurement between the extended wingtips.

Wrist The joint between the hand and the arm in the wing. Also called the carpal joint or the bend of the wing.

Adult Eurasian Griffon Vulture. Spain, 23.11.2009 (DF)

HAWK-WATCHING IN AND AROUND EUROPE

Keith L. Bildstein and Anna Sandor

Field guides are the backbones of successful raptor-watching. World-class guides like this one allow the uninitiated to quickly acquaint themselves with a region's birds of prey. Raptors, in particular, can be notoriously difficult to distinguish in the field and the present offering will be of great value in helping raptor-watchers, and raptor biologists for that matter, to correctly identify the birds that they see. Furthermore, seeing lots of raptors with this field guide in-hand will speed the rate at which raptor-watchers build their identification skills.

Unfortunately, because they are secretive and wide-ranging for most of the year, raptors tend to be difficult to see, let alone to identify. This general rule changes for many species during migration, however, offering numerous opportunities for seeing large numbers of birds of prey at close range. Although raptors often migrate across broad fronts – particularly at the beginning and end of their migratory journeys – many predictably aggregate in large numbers along well-established migration corridors, sometimes congregating by the tens of thousands at specific geographic features that include mountain ridges and passes, narrow coastal plains, isthmuses and peninsulas. For raptors, traditional migration corridors usually occur along what are known as 'leading lines', geographic or topographic features such as mountain ranges that are orientated along or near the preferred direction of travel and that provide updrafts for low-cost soaring flight, as well as along 'diversion lines', including land–water interfaces and lowlands next to high mountain ranges, where migrants concentrate not because they are attracted to them but because they are trying to avoid what lies beyond (Bildstein 2006).

Because many raptors hesitate or refuse to cross bodies of water that are wider than 25 km, raptor migration 'bottlenecks' occur in areas that allow migrants to forego or reduce the lengths of extensive flights over water. Water avoidance in the Europe–Africa migration system is best seen at places such as the Strait of Gibraltar at the western end of the Mediterranean, the Bosphorus at the north-eastern corner, and the Strait of Messina between Sicily and south-westernmost peninsular Italy in the central Mediterranean (Bildstein 2006).

The daily passage of migrating raptors by the hundreds and even thousands of individuals along leading lines and diversion lines, and at migration bottlenecks, has intrigued scientists for hundreds of years. French zoologist Pierre Belon described spectacular movements of Black Kites over the Bosphorus thus: "If they had continued for a fortnight in the same strength as on that day we could have surely said that they were in greater number than all men living on the earth…" (Nisbet & Smout 1957). Historically, such concentrations increased the vulnerability of many populations of raptors to human threats including shooting and trapping (Zalles & Bildstein 2000, Bildstein 2006). More recently, well-timed visits to established watch-sites along traditional migration corridors have provided raptor enthusiasts and hawk-watchers with excellent opportunities for seeing large numbers of migrating raptors at close range, creating some of the best situations for using this field guide to hone one's identification skills.

The hobby of raptor-watching has some of its deepest roots in and around Europe, and many of the world's most famous raptor migration watch-sites are found there. With this new field guide in hand, watching birds of prey at such sites offers one of the best ways to develop an appreciation for the many rules and complexities of both raptor identification and raptor migration. Well-timed visits to such sites provide opportunities for seeing large numbers of birds of prey and in the company of other enthusiasts who can help you identify them. Below we describe several of these sites and the raptors that one is likely to see at them. The real challenge in putting together these descriptions has been to reduce to eight the number of 'representative' watch-sites described. Several of the sites were chosen largely for their history, others for their diversity of species or the incredible magnitude of their migrations, and others still for their geographic settings and landscapes. Dozens of additional great European migration watch-sites are described in Zalles & Bildstein (2000).

FALSTERBO BIRD OBSERVATORY, SWEDEN

Located between 55º and 56º N, the Falsterbo Bird Observatory in south-western Sweden ranks as one of the northernmost raptor migration watch-sites in the world. It is also one of the world's oldest continually active sites. The hammer-shaped, 7-km long, flat and sandy peninsula that juts into the Baltic Sea, 24 km across the Öresund Strait from western Denmark, is a natural collecting point and major autumn migration bottleneck for many of western Scandinavia's land-restricted migrants (Zalles & Bildstein 2000, Karlsson 2004).

The site, which was first described as migratory bottleneck in the early 1800s by zoologist Sven Nilsson, gained fame as a raptor migration hotspot on the heels of Gustav Rudebeck's painstaking investigations of migration geography in the region in the 1930s and 1940s. Rudebeck backtracked, on a bicycle, the sources of individual streams of migrants and mapped their movements towards the site through south-western Sweden. His empirical approach allowed him to develop a model for the concentrated nature and location of the migration that used a combination of the site's coastal diversion lines, predominant winds, and a series of habitat-associated leading lines inland to explain each day's migration (Rudebeck 1950). His accurate observations also laid the foundation for understanding the seasonal progression of the migration, starting with the acute passage of most of the site's European Honey-buzzards over the course of several days in late August–early September, and concluding with the decidedly more protracted passage of Northern Goshawks in October and early November.

Falsterbo has attracted the attention of numerous writers and researchers over the years. Anyone planning a visit to the watch-site is recommeded to read the colour-illustrated and informative account *Wings over Falsterbo* (Karlsson 2004). Ulfstrand *et al.* (1974) provide an additional useful overview of the site and the visible migration to be seen there. Animal ecologist Nils Kjellén has focused his attention on age and sex differences in the migration at Falsterbo, and has linked both annual fluctuations in age and sex ratios, and age and sex differences in the timing of the migration, to critical aspects of the population biology and ecology of the species involved (Kjellén 1992, 1994, 1998). Kjellén (1997) has also assessed the degree to which Falsterbo serves as a regional bottleneck by comparing the magnitude of migration there with published estimates of Swedish populations of migratory raptors. His analysis suggests that, on average, the site records the movements of 38% of Sweden's Red Kites and 33% of its European Honey-buzzards, as well as 10–20% of its Marsh Harriers, Eurasian Sparrowhawks, Common Buzzards and Peregrine Falcons.

Thirty-one species of raptors are recorded as migrants at Falsterbo; 15 species are regular migrants. Approximately 40,000 raptors are seen in autumn. On average, more than 50% of the migration is made up by Eurasian Sparrowhawks (>17,000; 45,000 in 2012). The second most numerous raptor is the nominate subspecies of the Common Buzzard (30% of the migration; >10,000). Other significant migrants include European Honey-buzzard (>4000), Red Kite (>800), Rough-legged Buzzard (>800), Common Kestrel (>500), Osprey (>200), and Merlin (>200). Other birds seen in high numbers include (2012 total count/average): Barnacle Goose (>180,000), Common Eider (>90,00), Wood Pigeon (490,000), and Chaffinch/Brambling (>2,400,000).

Together with several sites in neighbouring Denmark, including Stevns Klint, directly across the Baltic Sea from Falsterbo, and Stigsnæs on the south-west coast of Sjaelland (Zalles & Bildstein 2000), Falsterbo offers the best opportunity for observing concentrated raptor movements in all of Scandinavia, especially during the peak passage around the first and second weeks of October.

Full-season counts have been conducted at Falsterbo by the Swedish Environmental Protection Agency since 1973. From 2001, counts have been made at Nabben at the southern end of the peninsula daily from 1 August to 20 November (Kjellén 2001). The Agency also operates the Falsterbo Bird Observatory in the town of Falsterbo on the peninsula, and they maintain an active website (www.falsterbofagelstation.se) that provides useful information about raptor migration and other ornithological events in the area.

COL D'ORGANBIDEXKA, FRANCE

Since 1980, Organbidexka Pass, which is believed to be the most important raptor migration bottleneck in the western Pyrenees, has been a *col libre*, or 'shooting-free zone'. In the late 1990s, there were more than 6,000 shooting hides along 200 km of ridges of the Atlantic Pyrenees. Although most hunters target passerines and pigeons, raptors are often also killed (Devisse 2000). The French League for the Protection of Birds (LPO Aquitaine) monitors the movements of the raptors at the site (Urcun, pers. comm.).

The watch-site, situated in the northern Basque country of southern France, 1,283 m above sea level, in the heart of the Irati Europe's most extensive beech forest, offers one of the best opportunities in Europe for observing large numbers of both Red and Black Kites.

Although avian biologists have long speculated on the extent of visible migration in the Pyrenees, little had been published on the movements of birds through this sparsely populated part of Europe until the early 1950s when David and Elizabeth Lack reported the results of three autumns of migration 'reconnaissance' tours (Lack & Lack 1952). Anticipating a concentrated coastal migration, the two biologists instead discovered extensive large-scale inland movements among the north–south 'cols' or mountain passes in the western Pyrenees that funnelled raptors and other diurnal migratory species into concentrated streams of migrants.

The Lacks also uncovered the ancient Basque pastime of *La chasse de la palombe* or Wood Pigeon hunting, in which teams of hunters hurling a series of 'zimbelas', or small white wooden discs, below flocks of low-flying Wood Pigeons and Stock Doves, elicited an alighting response in the birds that caused them to fly lower still, either into a series of nets, or onto the ground, at which time a horn was sounded and the hunters 'let fly in every direction'. The so-called sport remains popular today, and estimates of the annual kill range into the tens of thousands of pigeons and doves. The hunters are not particularly specific in their targeting, and many raptors are also slaughtered in autumn.

This is the backdrop for Organbidexka Col Libre (OCL), which has been monitoring the movements of and protecting trans-Pyrenean migrants since it was founded in 1979. In addition to Le Col d'Organbidexka, which is located on the northern slopes of Pic d'Orhy, halfway between Saint-Jean-Pied-de-Port and Tardets, OCL conducts counts and protects raptors at two other important watch-sites in the western Pyrenees, Le Col de Lizarrieta, on the border with Spain approximately 20 km south of Ascain, and Lindux, a Napoleonic fortification, 30 km south of Saint-Jean-Pied-de Port and several km north-west of Col de Roncevaux, where Roland was slain in AD778 while conducting a rear-guard action for Charlemagne.

The daily count is conducted annually from 15 July until 15 November, from sunrise until sunset.

Fourteen species of raptors are recorded as regular migrants at Organbidexka, and another seven are irregular migrants, although there are days when 20 species can be seen. Approximately 50,000 migrants are seen in autumn. Three species, European Honey-buzzard (23% of the overall flight; >12,000), Black Kite (67%; >35,000), and Red Kite (8%; >4,500), together make up 95% of all raptors seen. Most migrants at the site fly relatively low while crossing the pass, making them easy to see and identify. Opportunities for seeing large numbers of migrants occur mid- to late August during the peak movements of Black Kites and European Honey-buzzards. October is the best time to see Red Kites, which are rare migrants elsewhere in Europe, and Booted Eagles, which rarely occur this far north.

Common Cranes (>20,000) also migrate at the site. One additional notable aspect of the site is the late October migration of well over 100,000 Wood Pigeons and Stock Doves, both of which are legal game on migration. The autumn passage of these two species attracts thousands of hunters, many of which operate near the watch-site. Col d'Organbidexka is one of only a few raptor migration sites that records the numbers of gunshots heard as well as the numbers of migrants seen, and the current single-day record of 25,360 shots heard on 28 October 1982 highlights the degree to which shooting, much of it indiscriminate, persists in the region.

Although all of OCL's watch-sites are easy to find, the best place to begin a visit is at OCL headquarters at 11 Rue Bourgneuf, F-64100 Bayonne, France. One can find useful information on the www.migraction.net website as well.

STRAIT OF GIBRALTAR, SPAIN AND GIBRALTAR

The narrow body of water that connects the western end of the Mediterranean Sea to the Atlantic Ocean is also one of the most identifiable landscapes on Earth, and one of its most prominent migration bottlenecks, a 14 km-wide sea passageway across which hundreds of thousands of central and western European raptors travel en route to wintering areas in West Africa.

The fact that large numbers of raptors concentrated in southern Iberia before streaming into West Africa has been known to science since the late 1700s (Nisbet *et al.* 1961). British officer and ornithologist H. L. Irby was the first to detail the timing of the migration, as well as the role that cross winds played in determining the likelihood and location of the passage (Irby 1875). However, it was not until the 1960s that the magnitude of the passage became known (Evans & Lathbury 1973, Bernis 1980). Since then a number of researchers, most notably Gibraltar native Clive Finlayson (1992), have studied and reported on the migration there.

The narrow channel that separates Europe from Africa provides ample evidence for the extent to which raptors differ in their willingness to fly over water. Indeed, although the Strait appears to be a minor hindrance for some, it presents a formidable barrier for others. Ospreys, European Honey-buzzards, harriers, Peregrine Falcons, and other migrants with powerful flapping flight regularly cross the Strait almost immediately upon reaching land's end, whereas Eurasian Griffons, Black Kites, Booted Eagles and other obligate soaring migrants spend up to a week or more milling about in southernmost Iberia waiting for the right weather. Although such species' hydrophobia plays havoc with counting at the site, it also creates first-rate opportunities for birding there.

In general, migrants approach southernmost Spain and Gibraltar across a something of a broad front. With few exceptions, however, most cross the Strait in *streams* in a series of narrow-frontal movements, with the exact point of departure along the length of the passageway depending upon predominant winds. Movements tend to be greater overall and the migration heaviest at the eastern end of the Strait when 'Poniente' or westerly cross winds prevail, and lesser overall and heaviest towards the middle of the Strait when the far more dangerous 'Levante' or easterly cross winds prevail, the latter substantially increasing the likelihood of migrants being blown out into the Atlantic.

Thirty-four species are recorded as regular migrants at the Strait of Gibraltar, 25 of which are regular migrants. Approximately 230,000 and >260,000 migrants are seen in spring and autumn, respectively. Black Kites (50% of the overall total; >130,000) and European Honey-buzzards (30%; >85,000), make up more than two-thirds of the overall migration. Four other species, Short-toed Snake Eagle (7%), Booted Eagle (6%), Eurasian Griffon (3%), Egyptian Vulture (<1%) and Eurasian Sparrowhawk (<1%), migrate by the thousands to tens of thousands. Aside from being a great place to see migrating Old World vultures, the Strait of Gibraltar is also a great place to see three species of European harriers (Marsh, Hen and Montagu's), as well as the occasional Lesser Kestrel, Common Kestrel, Eurasian Hobby and Peregrine Falcon. Rarities, including Rüppell's Griffon Vulture and Eleonora's Falcon, can been seen among the huge flocks of more common species (Harris 2013).

The late-summer and early-autumn movements of Black Kites and European Honey-buzzards are truly spectacular. Most kites pass in July and August, whereas most honey-buzzards do so during a brief period at the end of August and early September. Kites tend to cross along the central and western parts of the Strait, whereas honey-buzzards, which typically approach along coastal Mediterranean flight lines, are far more likely to depart from the Rock of Gibraltar at the eastern end of the Strait.

In addition to soaring raptors, tens of thousands of White Storks and thousands of Black Storks can be seen migrating at the site in July and August and in September and October, respectively.

Equally systematic, albeit proportionately smaller, counts of spring migrants occur along the coast of southernmost Spain between the towns of Tarifa and Algeciras, at a time when birds crossing from Morocco on their return migration often pass at close range while flying close to the surface of the water.

The principal stream of migration shifts along the more than 20 km length of the Strait depending upon the wind, and migration at the site is all-but-impossible to track from a single lookout. Hawk-watching is best from a series of watch-sites, including the Rock of Gibraltar, as well as from a number of points in southern Spain between Punta del Carnero, south of Algeciras, west to Punta Marroquí, near Tarifa. The watch-site on the Rock of Gibraltar is operated by the Gibraltar Ornithological and Natural History Society; those in Spain are coordinated by Programa Migres, in cooperation with the Government of Andalucía. Both organisations maintain active websites (www.gonhs.org and www.fundacionmigres.org). Programa Migres has produced a useful *Guide to the Common Birds of the Strait of Gibraltar.* The guide and maps of the watch-sites are available at the Huerta Grande Visitor Centre for Los Alcornocales National Park, on the main coastal highway several miles west of Algeciras, which is the best place to begin a visit to the site. Clive Finlayson's *Birds of the Strait of Gibraltar* (1992) provides an excellent history of the site and well as useful details regarding the timing, ecology and geography of each species' migration.

THE STRAIT OF MESSINA, SICILY–CALABRIA

This spring coastal mountain watch-site, which is one of the most important bottlenecks for migrants using the Central Mediterranean Corridor, overlooks the 3 km-wide Strait of Messina, the body of water that separates the 'toe' of the Italian peninsula (Calabria) from north-eastern Sicily. Counts are made from both sides of the Strait along the slopes of Monti Peloritani in Sicily, as well as along the coast of Calabria. Raptors cross from Sicily to Calabria along a relatively broad front with the greatest concentrations occurring along 20 km at the northern part of the Strait, with the exact crossing depending on wind and general weather conditions. The presence of clouds and fog is strictly connected with the time of the passage. In early morning and late afternoon there are fewer thermals and birds pass over in flapping flight. In autumn, most of the birds of prey are concentrated in the mountains of Aspromonte National Park in Calabria.

Sadly, this site is well known among bird protection associations for the raptor shooting that has been happening there for decades. In the late 1970s, raptors and storks were being shot from dozens of elaborate, multi-person concrete bunkers in the Peloritani Mountains in spite of regional and national prohibitions. Raptor conservation protest camps were initiated in the region in 1981, and counts of both migrants and numbers of shots heard started in 1984. By the late 1990s, many shooting bunkers had been abandoned (Giordano *et al.* 1998). Shooting continued regularly on the Calabrian side of the Strait as recently as 2002. Despite the activities of conservationists in Calabria shooting currently remains an episodic problem there, although this activity is now rare in Sicily.

In 1984 Sicilian environmental associations established a study and surveillance camp to help protect migratory birds, still held by the Mediterranean Association for Nature in collaboration with WWF and NABU (Germany). Since then 37 species of raptors have been recorded on migration – no single site in Europe has recorded such a large variety of raptors. Two distinctive subspecies, rare elsewhere in Central–Western Europe, are regularly observed at the Strait as well: the *calidus* race of Peregrine Falcon (Corso 2001) and Steppe Buzzard, the *vulpinus* race of the Common Buzzard. The first documented observation for Italy of a Crested Honey-buzzard (*Pernis ptilorhyncus*) was made in May 2011 (A. Scuderi in Janni & Fracasso 2013). Vagrants include Black-shouldered Kite, Black Vulture, Levant Sparrowhawk, Steppe Eagle, Eastern Imperial Eagle, Greater and Lesser Spotted Eagles, and Amur Falcon. Yet another highlight of the Strait of Messina is the possibility of seeing the rare and local *feldeggii* race of the Lanner Falcon (Corso 2000).

The Strait of Messina is now recognised as one of the best places in the Western Palearctic to see the spring migration of the globally endangered Pallid Harrier (Corso 2004), together with the endangered Lesser Kestrel. Occasional irruptions of Red-footed Falcons also occur there (A. Giordano pers. comm.).

Annual spring raptor counts increased from 3,198 in 1984 to more than 40,000 in recent years, including 35,000 European Honey-buzzards. Other common species include Marsh Harrier (>3,000) followed by Black Kite (*c.*1,000), Common Kestrel (>900), and Montagu's Harrier (>800). Red-footed Falcon (a record number of >7,000 in 1992) is also common, along with Eurasian Hobby (>200) and Lesser Kestrel (>200). Egyptian Vulture, Lesser Spotted Eagle, Booted Eagle, Saker Falcon and Peregrine Falcon are less common regular migrants.

April typically has high species diversity, including some rarities, but low numbers (one day in mid-April more than 100 raptors were seen, but of 17 different species). Harriers are the earliest migrants, peaking as early as the first half of that month. The first two weeks in May have high overall numbers (up to 3,000/5,000 a day) but fewer species, with European Honey-buzzards making up the overwhelming majority of the passage.

The first autumn count occurred in the National Parks of Aspromonte in 2000 (Guglielmi *et al.* 2003), and 20,000 raptors were counted there between 11 August and 10 October 2012 (Grasso *et al.* 2012). More information can be found on the website of the Mediterranean Association for Nature, which is involved in studying and protecting migratory birds over the Strait of Messina (www.migrazione.it).

BURGAS, BULGARIA

Reports on the migration of soaring raptors using the Via Pontica (west coast of the Black Sea) migration corridor at the Bosphorus were published in the late nineteenth century (Alleon & Vian 1869, 1870). In Bulgaria, the Black Sea coast and the nearby hills play an important role in the orientation of these migrant birds; and the nature of the coastline near the town of Burgas creates a significant bottleneck, which is the best-known watch-site on the Via Pontica (Zalles & Bildstein 2000). From Cape Emine, the coast turns sharply west for 15 km, along the northern edge of Burgas Bay, and then continues south and west in a stepped fashion for a further 20 km. The Black Sea reaches its westernmost extremity near the town of Burgas, which is an ideal place for observing autumn migration. Beyond Burgas the route diverges: some birds follow the coast, while others continue inland (Michev *et al.* 2011).

Counts at Burgas Bay started in 1978 (Michev & Simeonov 1981) from a dyke on the NE shore of Lake Atanasovsko. Research at the site is part of International Counts of Soaring Birds in the Western Palearctic. Although the site is decidedly 'low key', it remains an important concentration point along this significant migration corridor in eastern Europe.

Around the city of Burgas, several lakes and wetlands host migrant waterfowl, pelicans, waders, gulls and terns in spring and autumn as well. The shallow, salty Lake Atanasovsko, just north of the city, records more than 300 bird species. One of the world's rarest birds, the Slender-billed Curlew, was last reliably seen here in 1993 (Harris 2013).

The Kableshkovo Hills, located a few miles north of Burgas, seem to benefit from the most concentrated passage of soaring birds: the average count (2004–2011) is 150,000 individuals in spring and 270,000 in autumn, made up mainly of White Pelicans, Lesser Spotted Eagles, Common Buzzards and White Storks (Harris 2013).

Thirty-three species of raptors were recorded at Burgas between 1979 and 2003. The mean number of migrating raptors observed in autumn is close to 40,000, with a clear trend towards increasing numbers in recent years (Michev *et al.* 2011). Count data suggest that Burgas is one of the most important sites for monitoring the migration of soaring birds in Europe, and the most important for the autumn migration of several species, including White and Dalmatian Pelicans, White Storks, harriers, Levant Sparrowhawks, Lesser Spotted Eagles and Red-footed Falcons. One of the most numerous migrants is the European Honey-buzzard with the main period of migration occurring between late August and early September (8,779 individuals on 4 September 1996), the same time at which numbers of Black Kites and White Storks peak (Michev *et al.* 2011). Two subspecies of Common Buzzards migrate at the site, the nominate race and the Steppe Buzzard, with the latter being far more common. Lesser Spotted Eagle migration peaks between late August and early October.

More information can be found on the website of the Central Laboratory of General Ecology, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences (www.ecolab.bas.bg).

BOSPHORUS, TURKEY

The Via Pontica migration corridor along the western coastline of the Black Sea is a major route for raptors in the region (Bijlsma 1987). In both spring and autumn, raptors migrating along the corridor are funnelled by the narrow bridge that links Europe and Asia at the Bosphorus (Cramps & Simmons 1980), where more than 167,000 migrants were observed from 22 September to 13 October 2008, (Milvus Group, unpublished.). Most of the world population of Levant Sparrowhawks and Lesser Spotted Eagles may migrate at the site (Bijlsma 1987).

The Bosphorus is the 30 km-long, 1.5 km-wide, N–S strait between the Sea of Marmara and the Black Sea, separating European from Asian Turkey. Migrants can be seen throughout the strait, which includes Istanbul and its suburbs. Locations of the flight-lines change according to wind direction and time of day. Autumn watch-sites include two hilltops, Büyük Çamlica and Kuçuk Çamlica, on the Asian side of the strait. A hilltop near Sariyer, 15 km north of Istanbul on the European side, is good in both spring and autumn (Zalles & Bildstein 2000). The site is not regularly monitored.

Twenty-nine species appear to be regular migrants in spring; 31 or 32 are regular migrants in autumn (Zalles & Bildstein 2000). The largest movements of birds of prey occur on days of light northeasterly winds. The main species found migrating were (with total numbers recorded in brackets) White Stork (207,145), Black Stork (6,194), European Honey-buzzard (8,997), Common/Steppe Buzzard (12,949), Greater/Lesser Spotted Eagle (4,309) and Eurasian/Levant Sparrowhawk (5,224) (Porter & Willis 1968).

According to the Milvus Group's count data, >149,000 raptors passed through here during the 19 days of counting. Most of the birds were Common Buzzards (>79,000, with a peak of >8900 individuals on the 29 September), and Lesser Spotted Eagles (>60,000, with a peak of >23,000 birds on the 30 September). Other species observed in high numbers were Short-toed Snake Eagle (>4800), Levant Sparrowhawk (>3000), Eurasian Sparrowhawk (>1700), Booted Eagle (194) and European Honey-buzzard (178). The third most numerous migrant during the same period was Black Stork (>15,000).

The following website offers additional details: http://milvus.ro/raptor-migration-watch-site-at-bosphorus/307.

BATUMI, GEORGIA

This major bottleneck along the southeastern coast of the Black Sea has only recently been discovered as the most important autumn flyway in Eurasia. The watch-site provides an opportunity to see large numbers of migratory raptors during their outbound and return migrations. What makes Batumi special is the close juxtaposition of the Black Sea coast and the formidable Greater Caucasus mountain range several km to the east, which creates a narrow passageway through which hundreds of thousands of southbound migrants funnel each autumn. Depending upon the weather the passage can pass just a few metres overhead, making the movement spectacular and the birds easy to identify. Unfortunately this also makes the birds vulnerable to shooters and trappers. Eurasian Sparrowhawks have been trapped for falconry for a long time in Georgia, particularly along the western Black Sea coast (van Maanen *et al.* 2001). By the late 1990s Georgian law 'protected' migrants from such actions, but enforcement has remained insufficient in many areas, up to the present day. The Georgian Center for the Conservation of Wildlife began monitoring the movements of raptors and conducting education programmes near Batumi in autumn 2000 (van Maanen *et al.* 2001). Presently Batumi Raptor Count (BRC), a young and dynamic international team, conducts annual autumn counts, works to promote tourism and raises environmental awareness in the surrounding villages and schools, as well as working to put an end to illegal shooting at the site. In addition to counting the numbers of migrants, counters also record the numbers of gunshots heard.

The watch-sites are not easy to find, so the best way to prepare for a visit is via the BRC's website (www.batumiraptorcount.org), where visitors can find all the necessary information regarding travel, accommodation and guided tours.

Every autumn, from 15 August to 15 October, an international team of volunteer counters records a visible passage of more than 1,000,000 birds of prey, together with hundreds of European Bee-eaters, European Rollers and Black Storks. The counts are conducted in two small villages, Sakhalvasho and Shuamta, just north of Batumi, near the southeastern coastline of the Black Sea.

Thirty-five species of raptors have been recorded by the Batumi Raptor Count. Two species make up the majority of the passage: European Honey-buzzards (about 400,000 each autumn, or approximately 50% of the overall passage) and Steppe Buzzards (>250,000, or about 30% of the overall passage). Daily peak counts for both species reach 60,000 to 80,000 individuals. Other numerous species include Black Kite (>50,000), Marsh Harrier (*c.* 4,000), Montagu's Harrier (*c.* 3,000), Pallid Harrier (*c.* 1,000), Eurasian Sparrowhawk (>4,000), Levant Sparrowhawk (*c.* 4,000), Booted Eagle (*c.* 4,000), and Lesser Spotted Eagle (*c.* 4,000). Osprey (>50), Short-toed Snake Eagle (>600), Long-legged Buzzard (*c.* 100), Greater Spotted Eagle (>100), Steppe Eagle (>300), Red-footed Falcon (*c.* 300), Lesser Kestrel (>200), Common Kestrel (>300), and Eurasian Hobby (<500) also are seen in large numbers. Red Kite, Crested Honey-buzzard, White-tailed Eagle, Egyptian Vulture, Eurasian Griffon Vulture, Black Vulture, Hen Harrier, Rough-legged Buzzard, Eastern Imperial Eagle, Golden Eagle, Merlin, Lanner Falcon, Saker Falcon and Peregrine Falcon are observed in lower numbers.

The peak period of passage of European Honey-buzzards is at the end of August–beginning of September (with 179,000 individuals on 3 September 2012). At this time of the season large flocks, often of several thousand honey-buzzards mixed with Black Kites, can be seen daily. Late September into October is the best time to see large flocks of Steppe Buzzards, and high numbers of Lesser and Greater Spotted Eagles. Booted Eagles, Short-toed Snake Eagles and juvenile Steppe Eagles regularly join the spectacular passage.

EILAT, ISRAEL

Each spring, millions of birds of prey that have over-wintered in Africa set out from that continent for breeding areas in Europe and Asia. Some leave Africa via the Strait of Gibraltar at the western end of the Mediterranean, others via the Sicilian Channel in the central Mediterranean. Most, however, do so via the Middle East, where, in most years, the elliptical geography of the Eurasian–East African Flyway positions the bulk of the spring passage over the outskirts of the coastal resort city of Eilat, in southernmost Israel, at the head of the Gulf of Aqaba.

One's first impression of the rugged mountains west of Eilat is that this is not a place to watch migrating raptors. Aside from a blazing blue sky above, the Negev Desert landscape looks more lunar than earthly, and, indeed, Eilat may be the only migration watch-site on Earth where, while scanning for raptors, one can see more countries – four, namely Israel, Jordan, Saudi Arabia and Egypt – than trees. What Eilat lacks in plant life, however, it more than makes up for in migrating raptors. The site is one of only three raptor watch-sites in the world that has counted more than a million raptors in a single season, and it has accomplished this in spring, during the inherently 'thinner' return migration. With reports of 38 species recorded there, Eilat is also one of the world's most biologically diverse raptor watch-sites.

Published accounts of raptor migration in the region date from Tristram's mid-19th century reports of large-scale movements in Palestine and Sinai (Tristram 1865–1868). Sporadic counts in and around Eilat date from the late 1950s (Safriel 1968). Systematic, full-season counts date from 1977 when Christensen *et al.* (1981) reported more than 750,000 migrants at the site between February and May.

The most thorough description of migration at the site is Hadoram Shirihai and David Christie's 1992 paper in *British Birds*. *Raptor migration in Israel and the Middle East* provides a brilliant overview of 30 years of fieldwork in the region (Shirihai *et al.* 2000). The International Birding and Research Center (IBRC) maintains an active ringing station for raptors and other birds at and around its field station and headquarters north of Eilat. IBRC organises the counts, which, in most years, are made by one or more groups of volunteers both from within and outside of Israel. Those interested in visiting the site should contact the International Birding and Research Center at Eilat (www.arava.org/birds-eilat/).

Twenty-two species are recorded as regular migrants at Eilat; another 16 species are irregular or rare migrants. Approximately 830,000 and 20,000 migrants are seen in spring and autumn, respectively. Two species, the European Honey-buzzard and the Steppe Buzzard, together make up about 85% of the passage. Other numerically significant migrants include Black Kite (3% of the passage), Steppe Eagle (3%) and Levant Sparrowhawk (2%). Eilat is clearly one of the world's best sites for viewing the latter, a small *Accipiter* whose migratory tactics, including obligate flocking and soaring migration, as well as nocturnal movements, belie its taxonomic affinities. Eilat is also an excellent spot for viewing significant movements of the one of the world's largest long-distance raptor migrants, the Steppe Eagle, as well as a great place to see migrating Egyptian Vultures and Eurasian Griffons. Notable residents at the site include Verreaux's Eagle and the 'Barbary Falcon' race of the Peregrine. The return passage begins with Steppe Eagles in late February–early March, and continues with Black Kites and Steppe Buzzards in late March and early April; it concludes with the decidedly more acute flights of Levant Sparrowhawks in late April–early May, and European Honey-buzzards in early May. Although the passage can be high, on most days good numbers of the birds can be seen at close range, and almost always in good light. Counts are conducted from a large gravel car park in the shadow of Mount Yoash, several kilometres west of Eilat on the road to Egypt. A substantial, although far less studied, autumn migration also occurs at the site (Shirihai & Christie 1992).

NORTHERN VALLEYS, ISRAEL

The Northern Valleys is a lowland watch-site in the agricultural valleys north of the Samarian Hills and south of the Galilee Hills, along a 75 km E–W transect between the Mediterranean Sea and the Jordan River (Zalles & Bildstein 2000).

The migration count that occurs between early August and mid-October at the site has been underway since 1988. Before that date, between 1982 and 1987, it was conducted from the Kfar Kasem migration corridor. The count is the joint project of the Israeli Ornithological Center and the Israeli Air Force (D. Alon, pers. comm.).

The watch-site records 27 raptor species as regular migrants, with an average of 470,000 individual birds seen annually. The most numerous species is the European Honey-buzzard (>300,000, with a peak of 544,215 in 1997) (Alon *et al.* 2004) that often appears in endless streams on a very broad front, covering large portions of the sky around the third week of August and peaks towards the first days of September. On hot days they can migrate at very high altitudes. Levant Sparrowhawks (>40,000, with a peak of 70,311 in 2008) (D. Alon pers. comm.) arrive in huge flocks around 10 September, reaching their peak at the end of the month. Towards the third week of September Lesser Spotted Eagles (>90,000) appear gradually with their peak of 48,000 birds around 29 September–5 October.

In addition to raptors, White Storks (>230,000, with a record of 540,000 in 1997, peaking at the end of August) and White Pelicans (*c.* 40,000, peaking in mid-September) are seen migrating at the site (D. Alon pers. com.).

This chapter provides but a brief introduction to a handful of the better-known raptor migration watch-sites in and around Europe. Although most raptor watchers spend most of their time at a single, favourite site, those that make it a point to visit other watch-sites regularly quickly realise that much is to be learned in doing so. In addition to consulting the general references listed below, the Hawk Migration Association of North America's website at www.hmana.org provides additional information on these and other watch-sites in the region.

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MIGRATION ECOLOGY OF RAPTORS

Ian Newton

Migration in birds is often defined as a regular return movement between breeding and wintering areas. It occurs not just among birds that breed at high latitudes, with warm summers and cold winters, but also among species that breed in the tropics, with regular wet and dry seasons. In fact, migration occurs in any seasonal environment in which bird food supplies change predictably from abundant to scarce during the course of each year (Newton 2008, 2010).

Migration is assumed to have evolved wherever birds benefit from leaving their breeding areas for a period than by staying there year-round (Lack 1954). The usual reason that breeding areas become unsuitable during part of the year is lack of food, as plant growth stops for part of the year, and many prey-animals die off, hibernate or become inaccessible under snow and ice. In the case of the fish-eating Osprey, for example, lakes in the breeding areas freeze over in winter and fish retreat to deeper water, so become inaccessible; and in the case of the European Honey-buzzard, the bee and wasp grubs which form the diet are dormant or dead in winter. At high latitudes, days also shorten to such an extent in winter that many diurnal birds would have insufficient time to get enough food, even if food were available. So the reason why many birds move to lower latitudes in autumn is fairly obvious.

A more difficult question is why they bother to return in spring, when their wintering areas – many in Africa – seem perfectly capable of supporting them year-round. But by returning north in spring, migrants can exploit the seasonal abundance of food at high latitudes, as well as the longer summer days, and probably raise more young than if they stayed in their low latitude wintering areas, and competed with the birds resident there.

So whereas the advantage of autumn migration to lower latitudes can be seen as improved winter survival, the advantage of spring migration to higher latitudes can be seen as improved breeding success. Migration is assumed to occur when the net benefits of moving both ways outweigh the costs of staying in the breeding areas year-round. But these are just plausible ideas, practically impossible to test experimentally, but for which there is considerable circumstantial evidence.

GEOGRAPHICAL TRENDS

Among birds as a whole, the proportions of migrants among local breeding bird species increase with increasing latitude, as winters become more severe (Newton & Dale 1996, Newton 2008). Even in the mild climes of Morocco, 30% of all breeding bird species are completely migratory, wintering further south. This proportion increases with latitude, reaching more than 90% in the far north, in places such as Svalbard. The same trend holds among diurnal raptors (Figure 1), and the only species which winters in the far north, with at most only a few hours of twilight in mid-winter, is the Gyr Falcon, dependent mainly on Ptarmigan as prey. However, conditions are such that even the majority of Gyr Falcons move out of the high arctic for the winter. The important point is that a geographical trend in migratory behaviour occurs among birds (including raptors), which corresponds to the severity of winter.

This geographical trend is evident not just from comparing different species, but also within species. Many widespread raptor species are wholly resident in the southern parts of their breeding range and wholly migratory in the north, while in between they are partial migrants, with some individuals staying in their breeding areas year-round while others move out. Examples include the Common Kestrel and Common Buzzard. In general, the proportion of migratory individuals within a species increases with distance northwards, roughly corresponding to the level of reduction of food supply in winter. Among such partial migrants, migration is often more frequent in one sex than in the other, and among juveniles than adults (Newton 2008). Among short-distance migrants that winter within Europe, juveniles tend to leave before adults, and migrate further, as in the Common Kestrel, Common Buzzard, Red Kite, Eurasian Sparrowhawk and Northern Goshawk; but in long-distance migrants that winter in Africa south of the Sahara, adults tend to leave before juveniles, as in the Osprey, Eurasian Hobby and European Honey-buzzard (Kjellén 1992, 1994a, Newton 2008). Among Marsh Harriers tracked on migration from Sweden, in which juveniles migrated more slowly and shorter distances than adults, most wintered in West Africa (Strandberg *et al.* 2008).

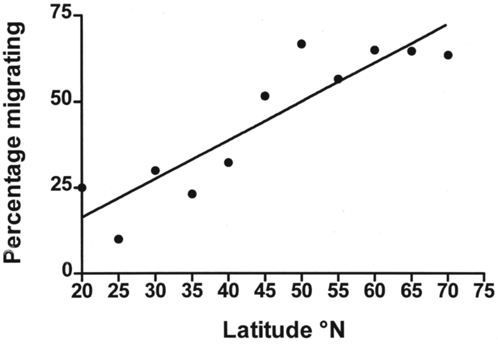

Figure 1. Proportion of raptor species breeding at different 5º latitudes in western Europe which migrate south for the winter. For this analysis, only species which move out completely from any given latitude were classed as migratory there. From Newton 1998.

RELATIONSHIP BETWEEN MIGRATION AND DIET

Whether particular species leave particular latitudes relates to their diets, and whether the foods they eat remain available at that latitude in winter. If one divides European raptors according to whether they feed primarily on warm-blooded prey (birds and mammals, which remain active and available in winter at high latitudes) and cold-blooded prey (reptiles, amphibians and insects, which become inactive and unavailable in winter), differences in migration are apparent (Figure 2). Within each group, the proportion of migrant species increases with latitude, following the general trend among birds as a whole (Newton & Dale 1996). At any one latitude, however, a larger proportion of species that eat cold-blooded than warm-blooded prey leave for the winter, while species with mixed diets are intermediate (Figure 2A). Furthermore, the cold-blooded feeders generally move longer distances than the warm-blooded feeders (Figure 2B). The reasons for this difference are fairly obvious, in that species that feed on cold-blooded prey and breed at high latitudes must winter in the tropics or the southern hemisphere if they are to have access to the same types of prey year-round.

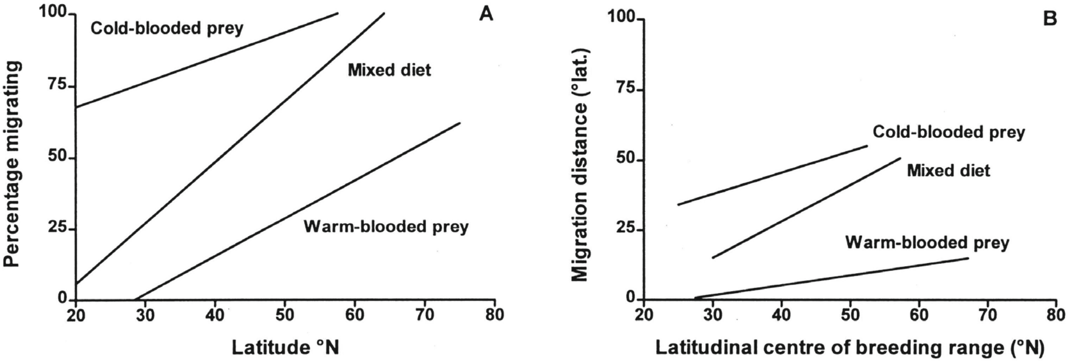

Figure 2. Migration in relation to diet in European raptors. A: Proportion of breeding species which migrate from different 5º latitudes. B: Distances moved, as measured by the latitudinal shift between the latitudinal centres of breeding and wintering ranges. Lines calculated by regression analyses. From Newton 1998.

Table 1. Wintering areas of Western Palaearctic raptors in relation to diet.

Wintering area	**Main prey types**		
	Warm-blooded	**Mixed**	**Cold-blooded**
North of Sahara	16	0	0
North and south of Sahara	5	8	2
South of Sahara	10	4	

Significance of variation between categories (examined by Monte Carlo randomisation test): $x^2_4 = 35.9$, $P<0.001$.

Of the 22 species of Western Palaearctic raptors that eat mainly warm-blooded prey, 16 spend the northern winter entirely within Eurasia, five partly in Eurasia and partly in Africa, and only one entirely in Africa (Table 1). Of the nine species that eat mainly cold-blooded prey, none winter entirely in Eurasia, two partly in Eurasia and partly in Africa, and seven entirely in Africa. Moreover, of the six insectivorous species, two winter partly and four entirely south of the equator, where the seasons are reversed. So, through migration, these latter species live in almost perpetual summer, thereby gaining access to plentiful insect food year-round. The 12 species with mixed diets show intermediate patterns. Such patterns again underline the link between migration and the seasonal changes in specific food sources (Newton 1979).

Food also seems to influence the timing of raptor migration. At the end of summer the first animals to disappear with the onset of cold weather at high latitudes are large insects, followed by reptiles and amphibians, while fish retreat to deeper water. Somewhat later, many small birds begin to migrate, and mammals begin to disappear, some hibernating and others spending increasing periods in sheltered sites where they are unavailable to raptors. Eventually the landscape is snow-covered, rendering small mammals even less accessible. Given this pattern, it is not surprising that insect-eaters, such as the European Honey-buzzard, are first to leave their breeding areas, followed by Ospreys, and later by bird-eating and mammal-eating species. During spring, the situation is reversed, with mammals appearing first in the environment and large insects last. The Steppe Eagle, which eats chiefly mammals, is the first to migrate north, passing through Israel mainly in early March, while the honey-buzzard, which eats insects, migrates last, mainly in May. The Steppe Eagle spends six months in its breeding areas, passing south through Israel mainly in mid October to mid November, while the honey-buzzard spends only three months in its breeding areas, passing through Israel mainly in early September. The eagle also has a longer breeding cycle than the honey-buzzard, with longer incubation, nestling and post-fledging periods (Leshem & Yom-Tov 1996a). But the general pattern is that raptor species which are the first to leave their breeding areas in late summer are also among the last to return there next spring, while species which are among the last to leave their breeding areas in autumn are among the first to return there next spring.

MODE OF MIGRATION

While most bird species travel on migration by using energy-demanding flapping flight, many raptors are able to travel by soaring and gliding, which is much less energy demanding. It is in the larger species that this ability is best developed, as their spread wings span a large area relative to body weight, and can thereby provide good lift in rising air currents. The larger raptors share this ability with some other large birds, such as storks and pelicans.

Raptor species that use passive soaring–gliding flight are not sharply separated from those that use powered flapping flight. Different species form a continuum between the two extremes, depending on their body size and wing shape, and in all soaring species the ratio of flapping to gliding can vary with air conditions at the time. Vultures and eagles are most dependent on soaring–gliding, followed in descending order by *Buteo* buzzards, *Milvus* kites, *Accipiter* hawks and *Pernis* honey-buzzards, and then by *Circus* harriers and *Pandion* Ospreys (Kerlinger 1989, Newton 2008). Falcons are more active fliers, less dependent on updrafts, but make use of them when available. This order of listing broadly follows the sequence of wing loading, from lowest to highest, and the variation in wing shape from long and broad, with slotted primary feathers, to narrow and pointed, with little or no slotting. It also reflects the dependence of the various species on updrafts, and hence the extents to which they take advantage of land-based topographic features and avoid long sea crossings. It is chiefly the falcons that regularly make long (<100 km) flights over water, and occasionally migrate at night, but other species (*Pandion, Pernis, Butastur* and others) do so in some parts of the world. The most extreme is the Amur Falcon, which each autumn crosses the Indian Ocean between India and East Africa on a journey sometimes exceeding 4,000 km. This over-water flight is assisted by prevailing winds. On the return spring migration, winds over the sea are less favourable, and migration is largely overland, up the east side of Africa and eastward across Asia.

Soaring species migrating overland gain lift from rising air, whether updrafts or thermals. Updrafts are formed when the wind, striking a slope or cliff, is deflected upwards, enabling 'slope soaring'. Long mountain ridges thus provide excellent flyways for soaring migrants in those places where the ridge lies roughly north-south, in a direction appropriate for migration. In such places, birds can glide for tens of kilometres without flapping (Kerlinger 1989). The Rift Valley, extending from the Middle East into Africa, provides such conditions over parts of its length.

Thermals are localised columns of rising air created through the uneven heating of the ground by the sun. These columns rise to high elevation, until they have cooled to the temperature of the surrounding air, where they often produce a cumulus cloud, marking their position. They begin each morning once the ground has heated sufficiently, but gather strength during the day. They climb gradually faster and higher, often reaching more than 1,000 m at noon, and then wane in the evening as the ground cools. Birds progress on migration by circling in one thermal to gain height, and then gliding with loss of height to the next thermal where they rise again, repeating the process along the route (Figure 3). This enables birds to travel across country at around 30–50 km per hour, depending on the rate and extent of rise within thermals and the distance covered between thermals (in turn dependent on the 'glide coefficient', which is the ratio between the horizontal distance covered by the bird and its altitude loss over that distance). Species with light wing-loadings ascend more rapidly so spend less time in each thermal; they also lose less height per unit distance in a glide, so they can travel further before having to climb again. They can also get underway earlier in the morning and continue later into the evening than species with heavier wing-loadings that are restricted to a shorter period each day when the thermals are strongest. The flight times of the smaller species migrating through Israel on thermals typically extend over 8–10 hours each day (beginning around 09.00) and the larger ones over 6–7 hours (beginning around 10.00). All species tend to make more rapid progress in the middle part of the day, when climbs are fastest and highest, and glides are longest. Particular species can travel across country twice as fast around noon than in the morning or evening (Spaar & Bruderer 1996).

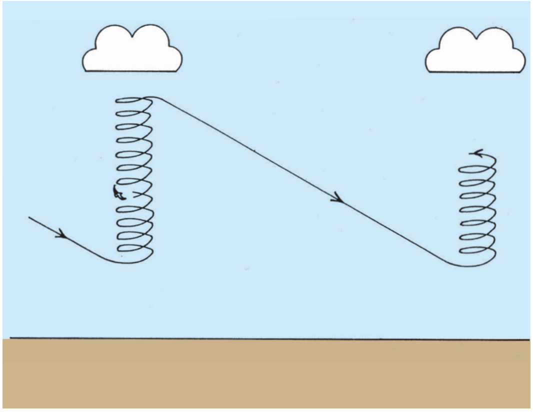

Figure 3. Soaring–gliding bird migration, indicating soaring within thermals, gaining height, and gliding between thermals, losing height. Thermals are often topped with cumulus clouds.

In Steppe Eagles studied in Israel, cross-country speed was related to the climb rate in thermals which averaged 1.9 m s^{-1} over the whole daily migration period, but reached up to 5.0 m s^{-1} around noon. Mean gliding airspeed between thermals was 56 km per hour which, allowing for climb times, gave a mean cross-country speed of 45 km per hour. The upper limit of migration was about 1,600 m above ground, but was mostly below 1,000 m (Spaar & Bruderer 1996). Smaller European Honey-buzzards and Steppe Buzzards achieved lower cross-country speeds, at 37 and 35 km per hour. However, in a 12-hour day, Steppe Eagles soared for only 6 hours and covered 270 km, whereas the two smaller species migrated for 10 hours and covered 360 km. Hence, although the largest species travelled faster between thermals, it did not cover more kilometres per day (Spaar & Bruderer 1996). In cooler climates, where thermals occur during a smaller part of each day, migration times are shorter, and larger raptors, such as Golden Eagles, travel for at most a few hours per day when using thermals, mostly between 12.00 and 14.00 hours. But when using mountain updrafts, which continue through the day, large raptors can migrate over longer periods. As expected, weather conditions also influence progress, as they affect the formation of updrafts and thermals, while rain can stop migration altogether.

Partly because of their dependence on thermals, all soaring landbird species migrate primarily by day. Taking advantage of topography, they often form into concentrated streams, using the same routes year after year, and crossing seas at the narrowest points. Crossings at the Bosphorus or Gibraltar are best accomplished in one long descending glide, in order to avoid laborious flapping flight. Early in the day, when conditions are not ideal, birds sometimes start a crossing, and having reached a few kilometres from shore, turn back to try again later. On their migrations, soaring raptors usually travel low enough to be seen with the naked eye and, with large numbers passing predictable places year after year, they can be counted by ground-based observers in ways that other, higher-flying or night-flying birds cannot. The seasonal timing of their migrations can thereby be assessed accurately and day-to-day passage can be related to weather and other conditions. Moreover, in some species, the different sex and age groups can be distinguished, enabling the movements of these different groups to be examined separately.

Well-known observation points for soaring migrants in western Eurasia include Falsterbo in Sweden, Gibraltar and the Bosphorus at either end of the Mediterranean Sea, the Black Sea coast in northeast Turkey, various localities in the Rift Valley in Israel and Suez in Egypt (see Bildstein & Sandor in this book). At these points, large numbers of soaring migrants pass in spring or autumn, with total numbers varying between tens of thousands and hundreds of thousands, depending on the site. At certain sites in the New World, much larger numbers can be seen, and several millions of soaring raptors and others cross between North and South America at the narrow land bridge at Panama (Bildstein 2006). In contrast to the soaring species, raptors and other birds that migrate primarily by flapping flight tend to migrate more on a broad front, as they are less dependent on topography, and do not concentrate to the same extent at short sea crossings or narrow land bridges. They can more readily cross larger stretches of water.

Many birds, whether soaring or flapping species, take somewhat different routes in spring and autumn, depending on wind and other conditions, as mentioned above for the Amur Falcon (Newton 2008, 2010). At least two major loops have been described for migration between Europe and Africa. In one, the southward movement occurs through Gibraltar and the northward one through Sicily–Italy (an anti-clockwise loop). In the other, a southward route occurs across Arabia, down the east side of the Red Sea and crossing to Africa at Bab el Mandeb, and the northward route occurs up through the eastern Sahara and up the west side of the Red Sea to cross from Africa at the Gulf of Suez (a clockwise loop). Both loops are used by many raptors, as well as by passerines and other kinds of birds. They have been demonstrated by counts on the different flyways, by ringing recoveries and by the satellite-based tracking of radio-marked birds (see Meyburg *et al.* 2003 for Steppe Eagle). A less marked clockwise loop was noted in individual Marsh Harriers which, in crossing the western Sahara, travelled northward in spring to the west of their southward route in autumn, associated with different wind conditions (Klaassen *et al.* 2010).

WEATHER EFFECTS

Birds in general prefer to migrate under clear skies with following winds. Clear skies facilitate navigation because the sun or stars – which are the main compass cues – are clearly visible; and following winds hasten the birds on their journeys, reducing their energy costs and also the risks of being blown off-course. In contrast, rain, mist and heavily overcast conditions, or strongly opposing winds, normally deter birds from setting off on migration, or cause birds already on the wing to settle if they are overland. These generalisations also apply to raptors, but soaring species operate under even greater constraints. To create an updraft from a ridge or mountainside, the wind has not only to be sufficiently strong, but must also strike the ridge at an angle, for if it flows in the same direction as the ridge, no significant updraft is created. In these conditions, a following wind may be of little or no help. The development of thermals is heat-dependent, so such up-currents are likely to operate for longer each day, and achieve greater heights, in warmer regions than in cold ones. Even in warm regions, however, strong winds from any direction can prevent thermals from developing, a situation which, in the absence of other updrafts, suppresses raptor migration. In the northern latitudes of Europe, migration of any kind is often stopped for up to several days at a time by rain or other adverse weather, but from southern Europe southward to the tropics, thermals can usually develop for part of every day in the migration seasons.

This does not necessarily mean that migration will be visible from the same locations every day, for as in other birds, migration streams are often shifted laterally by cross-winds. Thus, migrating raptors may pass localities up to several tens of kilometers apart on different days, depending on the strength and direction of the wind. To a large extent, the likelihood of strong migration on particular days during migration seasons can be predicted from examination of synoptic weather maps. But because birds differ in body size, flight mode and other aspects, they are affected by adverse weather to different extents, some species being able to fly in conditions that would ground others.

POSSIBLE SOCIAL INFLUENCES

Soaring species migrating along favourable routes often form long drawn-out flocks. One presumed advantage of migrating in this way is that it makes finding thermals easier, thus conserving energy. By watching the birds ahead that are already circling upward, a bird can head for them without wasting time and energy in thermal location. Use of radar in Israel revealed that, on peak migration days, the lines formed by flocks extended up to 200 kilometres or more, so that most individuals had before them a continuous route marked out by their predecessors (Leshem & Bahat 1999). However, it is difficult with raptors to tell whether the birds migrate in flocks simply because they share the same narrow migration route, and the same thermals and updrafts within it, or whether they are attracted to one another for other reasons. When leaving the top of a thermal, birds seem to depart individually. Not surprisingly, the biggest flocks are seen in relatively numerous species which migrate within a short time period, such as the European Honey-buzzard and Levant Sparrowhawk; but some insectivorous raptors, such as Red-footed and Amur Falcons, seem always to associate in flocks, whether on migration or not.

ENERGY NEEDS AND FEEDING

While birds that travel by flapping flight depend on internal energy for migration, those that use soaring–gliding flight depend largely on external energy, derived from the atmosphere. Our knowledge of the extent to which raptors feed on migration, and how much body fat they accumulate for each stage of the journey, is somewhat limited. In theory, migrant raptors could forage in the early mornings when conditions are unsuitable for soaring, and suffer no reduction in overall migration speed; but how much they do so is unknown. Those that winter in Africa migrate partly through desert or other terrain offering little food, and often birds travel in such large numbers over such narrow routes that most would have little chance of picking up a meal.

Nevertheless, many raptor species can be seen to feed on migration, or to fly with a full crop, especially those which hunt or locate their prey in flight. Bird-eating falcons and accipiters migrate at the same time as their prey, and could in effect survive by eating their fellow travellers. Ospreys have also been observed to divert from their paths to visit wetlands and search for and catch fish before moving on. Various harriers have been seen to migrate and hunt at the same time, and aerial insectivorous species have been seen to pause and forage if they encounter concentrations of suitable insects en route. The term ‘fly-and-forage’ has been used to describe this ‘eat-on-the-road’ strategy (Strandberg & Alerstam 2007). Eagles and buzzards normally hunt by a sit-and-watch strategy; and those that migrate long distances feed more episodically, on definite stopovers, and probably make large parts of their journeys without eating. This is also true of honey-buzzards, which seem to make little attempt to feed over most of their route, although they frequently descend to drink. These groups are among the raptors known to accumulate migratory fat (up to 30% of body weight in Steppe Buzzards, Gorney & Yom-Tov 1994). In North America, museum labels on skins of Swainson’s Hawks *Buteo swainsoni* and Mississippi Kites *Ictinia mississippiensis* collected at migration times often carried the note ‘very fat’ (W. S. Clark). Bald Eagles *Haliaetus leucocephalus* have been tracked on migration for up to 12 days without being seen to feed (Harmata 2002), and long-distance fasting has also been proposed for various other soaring raptors, which show long uninterrupted travel steps, implying the use of stored reserves (Meyburg *et al.* 1995, Kjellén *et al.* 1997, Håke *et al.* 2003). Even though they may make much of their journey on energy-saving soaring–gliding, therefore, it is clear that some raptors accumulate and use migratory fat like other birds. Whether there is a clear division in migratory fat levels between species that hunt on the wing and those that do not must await further research.

SATELLITE TRACKING

Recent satellite-based radio-tracking of individual raptors has provided much new information on the speed and duration of migration, on the routes and stopover sites used and on their behaviour en route. The use of Google Earth images has enabled exploration of the habitats used on migration. Most of these tracked birds made long journeys, some from one continent to another, and their need for thermals also led some to take indirect routes to avoid long sea-crossings. Their journeys were thereby lengthened by up to 50% over the shortest (great circle) routes.

Among birds as a whole, the flight speeds of different species need not correlate well with their migration speeds, because a large part of most migratory journeys is spent resting or foraging. In general, larger bird species fly faster than small ones, but partly because of their slower food-processing rates, large species take longer to accumulate the body reserves necessary to fuel the journey (Newton 2008). This size-related difference may be less marked among soaring raptors than most other birds because their cheaper flight mode reduces the time they must spend feeding to accumulate fuel. In addition, some raptor species can pick up food as they travel, as mentioned above.

One of the earliest satellite-based studies involved a Short-toed Snake Eagle, which was monitored every night on its autumn journey between France and Niger in West Africa (Meyburg *et al.* 1998). Every roost location was thus recorded, as were the distances travelled each day throughout the journey. These daily distances varied from 17 to 467 km (mean 234 km), and the whole migration of 4,685 km was accomplished in 20 days (Figure 4). Other raptors for which sufficient data were obtained have occasionally moved more than 500 km per day, with 746 km recorded from an Osprey through Europe (Kjellén *et al.* 2001), 663 km for a Black Kite through Europe (Meyburg & Meyburg 2009b), and 537 km for a Lesser Spotted Eagle through Africa (Meyburg *et al.* 2001). But these are extreme values, and daily distances of 150–250 km per day would be more typical. Inevitably, some non-stop sea crossings

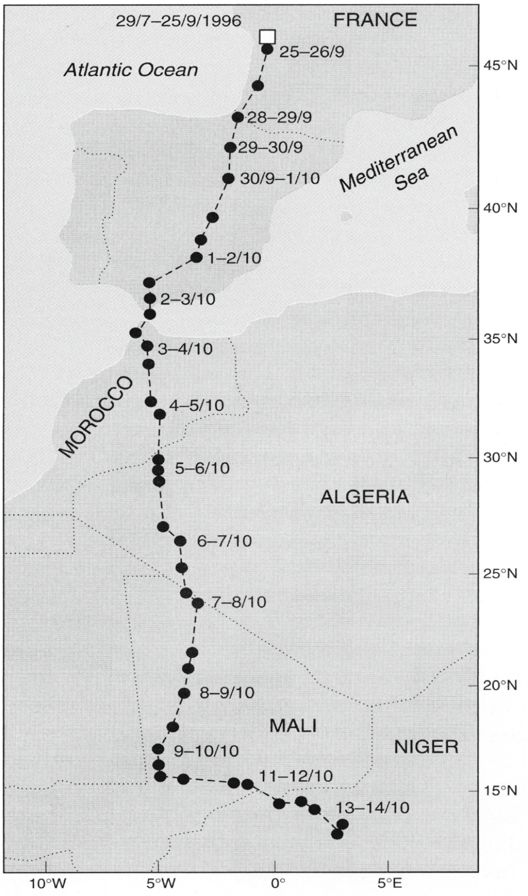

Figure 4. Migration of a satellite-tracked radio-tagged Short-toed Snake Eagle from France to Niger, showing the daily distances flown and the nightly stopping places. From Meyburg *et al.* 1998.

made by Amur and other falcons must be longer.

Comparing records from different individuals, the time spent on migration increased with the length of the journey, a trend apparent both between and within species, but with considerable individual variation (Newton 2008). Within species, the trend was most apparent among Peregrines and Ospreys, in which large numbers of birds were tracked from different parts of the breeding range (Newton 2008, Burnham *et al.* 2012). Overall, among long-distance migrant raptors journeys of around 2,000 km took, on average, around 20 days, and every additional 2,000 km added another ten days (Figure 5). It seemed that, on journeys exceeding 2,000 km, migration speed showed no tendency to increase with length of journey. This was presumably because soaring species required much less food to fuel the flights, and did not need to stop for long feeding periods during the journey (although some individuals clearly did). However, examination of short-distance Common Buzzards, migrating within Europe, showed that they generally moved more slowly, with some steps of their journey triggered by adverse changes in weather and food supplies. Adding these data to Figure 5 altered the relationship between duration and distance, with duration increasing approximately in proportion to the square root of distance (Strandberg *et al.* 2009b). The 12 Common Buzzards involved spent 4–44 travel days on their autumn journeys and 6–10 travel days over their spring journeys over distances of 452–1,449 km. Similarly, among 24 juvenile Steller's Sea Eagles *Haliaeetus pelagicus* tagged at nests in various parts of the breeding range, mean speed per day increased with length of journey (as measured by degrees of latitude travelled) (McGrady *et al.* 2003). Again, however, most of these movements could be considered short distance, at less than 2,000 km.

Not surprisingly, those species tracked between Europe and Africa travelled more rapidly over the Sahara (which offered excellent soaring conditions but no food) than over other parts of the journey where feeding stops were possible (for Short-toed Snake Eagle see Meyburg *et al.* 1998; for Osprey see

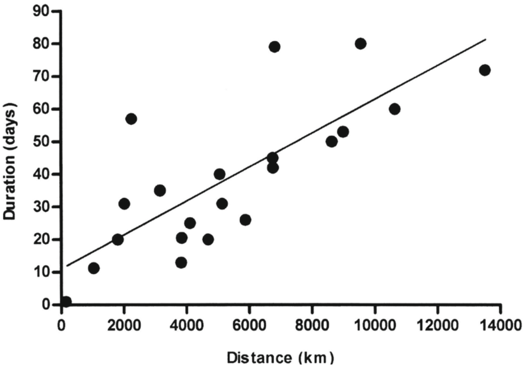

Figure 5. Relationships between duration and distance (left) in the autumn migrations of different raptor species, based on the mean values from different studies listed in Newton 2008: Table 8.3. Regression relationship: Duration (days) = 11.8 + 0.00493. distance (km), r = 0.75, P <0.001. No relationship was apparent between migration speed and distance: speed (km per day) = 116 + 0.0057.distance (km), r = 0.31, P = 0.162.

Kjellén *et al.* 2001; for European Honey-buzzard see Håke *et al.* 2003; for Egyptian Vulture see Meyburg *et al.* 2004; for Lesser Spotted Eagle see Meyburg & Meyburg 2009; for Eurasian Hobby see Strandberg *et al.* 2009c). Elsewhere some species broke their autumn journeys for up to several days at a time, apparently when they encountered good feeding areas. Once in the winter quarters, individuals of some species remained in one locality throughout their stay, and those individuals studied in successive years returned to the same breeding and wintering localities each year (for Osprey see Alerstam *et al.* 2006, for European Honey-buzzard see Håke *et al.* 2003, for Marsh Harrier see Strandberg *et al.* 2008). Like some other birds, some tracked raptors used different areas in Africa at different times in the non-breeding period, moving successively further south during their stay, apparently in association with southward shifts in food availability, related to previous rainfall. This behaviour was recorded in 30 Montagu's Harriers from Europe which used four different African areas in succession, each separated by more than 200 km, to which they also showed high fidelity in successive years (Trieweiler *et al.* 2013). Similarly, an adult Black Kite tracked from Germany to West Africa used three main areas in succession during the course of a single winter (Meyburg & Meyburg 2009b). Some Lesser Spotted Eagles wandered over many thousands of square kilometres in southern Africa, frequently making long moves during the course of their stay (Meyburg *et al.* 1995, 2004). This species was known from previous observations to move around according to rainfall, concentrating temporarily in areas of abundant food, such as recently emerged termites (Newton 1979). However, not all tracked eagles of this species moved over such large areas (Meyburg & Meyburg 2009a).

Among various long-distance raptors, no consistent difference was apparent between the duration of autumn and spring journeys, either from the mean values calculated for different populations or using the values for those individuals of each species tracked on both outward and return journeys (Figure 6). In some populations (or individuals) the autumn journey took longer, in others the spring journey. The biggest difference was recorded in a White-tailed Eagle which took markedly different routes at the two seasons, so that the autumn journey lasted 57 days (39 km per day) and the spring journey 67 days (81 km per day) (Ueta *et al.* 1998). However, even including this bird, the regression line relating the duration of autumn and spring journeys in different species was not significantly different from 0.5, which implies equality in the mean duration of both journeys. The longest-distance travellers between northern Europe and southern Africa, or between northern North America and southern South America, spent up to 152 days per year on migratory journeys (42% of each year).

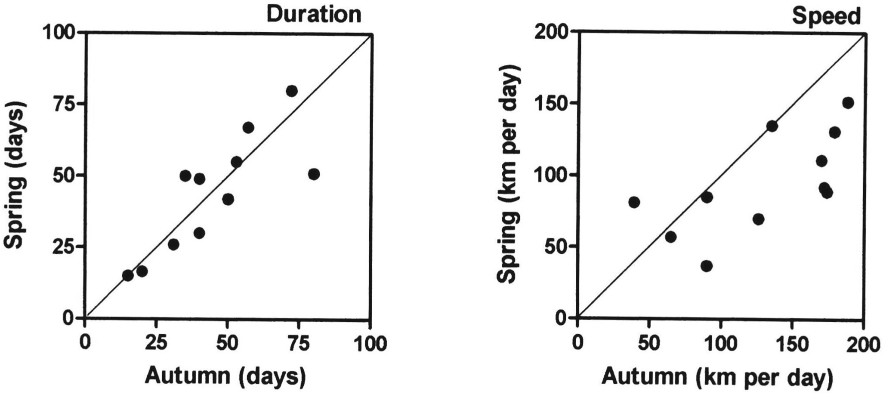

Figure 6. Relationship between the durations and speeds of the autumn and spring migrations of different raptor populations, based on the mean values from different studies listed in Newton 2008: Table 8.3 (but excluding a White-tailed Eagle which took markedly different routes in autumn and spring). The line on each graph shows the relationship expected if the two migrations were of equal duration and speed. Overall, no significant difference was apparent in the duration or speed between seasons (on a paired t-test for duration, t = 0.08, P = 0.94; for speed, t = -0.93, P = 0.37).

The large individual variation in the duration of migration within populations was mentioned above. Among Ospreys that bred in Sweden and wintered in West Africa, the total length of journey varied between 5,813 and 7,268 km (longest journey 1.25 times longer than the shortest), but this journey took between 14 and 55 days to complete (greatest value 3.9 times longer than shortest) in a sample of 13 individuals (Kjellén *et al.* 2001). Mean speeds varied between 108 and 431 km per day. Among Honey-buzzards over the same route, the journey varied between 6,299 and 7,091 km (longest journey 1.13 times longer than the shortest), and took between 34 and 70 days to complete (greatest value 2.06 times longer than the shortest) in a sample of nine individuals (Håke *et al.* 2003). Mean speeds varied between 93 and 209 km per day. In other species, equivalent journeys took up to three times longer in some individuals than others (Newton 2008: Table 8.3).

Over the same journey, no difference was apparent in the mean autumn migration speeds of juvenile and adult Ospreys. In European Honey-buzzards the average speeds of adults and juveniles on travelling days were similar, at about 170 km per day in Europe, 270 km per day across the Sahara and 125 km per day in Africa south of the Sahara. However, as the adults had fewer stopover days en route, they maintained higher overall speeds and completed their migration in a shorter time (42 days) than juveniles (64 days) (Håke *et al.* 2003). The spring journeys of several eagle species were slower in juveniles than in adults, mainly for the same reason (Newton 2008: Table 8.3). Although Peregrines and Ospreys often progress by flapping flight when soaring is not possible, their mean migration speeds were within the range of values recorded for other soaring species (Newton 2008: Table 8.3). In general, within regional populations, those adults that spent the longest periods on migration spent the shortest periods in their wintering areas, while no effect was apparent on the amount of time spent in the breeding areas.

Satellite tracking has also shown that individuals of some species, such as Osprey and European Honey-buzzard, start on migration as soon as they finish parental care or, in the case of juveniles, as soon as they become independent. But in other species some individuals (adults or young) move to a pre-migratory area where they spend some weeks before departing on their migration. This last behaviour has been recorded among Marsh Harriers in Sweden, Montagu's Harriers in Spain and Peregrines in Greenland (Strandberg *et al.* 2008, Limiñana *et al.* 2008, Burnham *et al.* 2012).

Tracking studies have also taught us more about the hazards facing migrating birds. One study involved more than 90 trans-Saharan journeys by four species of raptors (Osprey, European Honey-buzzard, Marsh Harrier and Eurasian Hobby) from Sweden (Strandberg *et al.* 2009a). Aberrant behaviour occurred on 40% of these crossings, indicating difficulties or hazards for the migrants. These events included changing course abruptly, slow travel speeds, interruptions, aborted crossings followed by retreat migration out of the desert, and failed crossings due to death. The mortality rate associated with Saharan crossings was significantly higher among juveniles (31% of crossing attempts, first autumn migration) than among adults (2% per crossings attempts, autumn and spring combined). Mortality associated with desert crossings made up about half of the total annual mortality recorded for juveniles. Among the survivors, aberrant behaviours resulted in late arrival in the breeding areas and increased the probability of breeding failure.

In some species, ringing and satellite-based radio-tracking have shown that different birds from the same breeding locality can migrate to widely-separated wintering places, and conversely that birds from a single wintering locality can migrate to widely separated breeding places. Individuals may return year after year to their own breeding and wintering sites, but have different sets of neighbours at the two seasons. For example, Peregrine Falcons caught wintering on a 50 km stretch of coast in eastern Mexico were tracked to breeding areas that lay across much of North America and western Greenland, with a west–east spread of more than 5,000 km (McGrady *et al.* 2002). Similarly, Peregrines from any one breeding area wintered at sites scattered over a wide range of latitudes from southern North America to northern South America, mixing with Peregrines from other breeding areas (Fuller *et al.* 1998, Burnham *et al.* 2012). Again, individuals tracked in more than one year showed fidelity to their own breeding and wintering sites, confirming trapping results from ringed birds (Newton 2008, Burnham *et al.* 2012). In some species, even breeding partners tracked by satellite wintered in areas separated by more than 1,000 km, as shown in Ospreys, Greater Spotted Eagles and others (Kjellén *et al.* 1997, Meyburg & Meyburg 1998).

Finally, satellite tracking has for several species confirmed the implications from ring recoveries that, in raptor species in which individuals migrate between Europe and Africa and do not breed until they are two or more years old, at least most young birds stay in Africa for the whole of their first year or more, and do not return to their breeding areas until they are approaching breeding age (for Osprey see Dennis 2008; for European Honey-buzzard see Hake *et al.* 2003; for Egyptian Vulture see Meyburg *et al.* 2004). This means that individuals in full juvenile plumage are seen in Europe chiefly during the few weeks between leaving the nest and leaving the continent on their first southward migration. However, among a small number of tagged Short-toed Snake Eagles, some individuals remained in Africa in their second summer while others migrated north to the breeding range, arriving later and departing earlier than breeding adults (Yanez *et al.* 2014). Based on observations of migrants in southern Italy, the same holds for Honey-buzzards (Panuccio & Agostini 2006).

Summary

Migration is assumed to occur in species in which individuals survive better by wintering at lower latitudes than they breed, and breed at higher latitudes than they winter: when the benefits of the two-way journey outweigh the costs of staying in the same place year-round.

The proportion of breeding raptor species that are migratory increases from south to north within Europe. Also, many widespread species are totally resident in the southern parts of their breeding range and totally migratory in the north, and partial migrants in between.

As well as latitude, diet influences migratory habits. In general, species that eat cold-blooded insects, amphibians and reptiles are more migratory than species that eat warm-blooded birds and mammals. The former also in general migrate longer distances, arriving in their breeding areas later in spring and departing earlier in autumn.

Raptors form a continuum from species that migrate almost entirely by soaring–gliding flight to those that migrate almost entirely by powered flapping flight. The former is less energy-demanding, but largely restricts the birds to travelling by day, at relatively low altitude and overland, avoiding all but relatively short water crossings. Soaring species often follow the same routes from year to year, concentrating to pass through specific bottlenecks where they can be readily counted.

The tracking of radio-tagged individuals has provided much new information on the speed and duration of migratory journeys, on the routes taken, and on the behaviour and mortality occurring en route. Raptors typically travel overland at speeds of 150–250 km per day. In species that migrate from Europe to Africa, most mortality occurs in the Sahara Desert, especially among juveniles on their first journey. In some species, individuals return not only to the same breeding areas in successive years, but also to the same non-breeding areas. Individuals of some species which migrate to Africa use a succession of widely separated areas during the course of a single non-breeding season to which they may also return in subsequent years.

In raptor species in which individuals migrate between Europe and Africa and do not breed until they are two or more years old, at least most young birds stay in Africa for the whole of their first year or more, and do not return to their breeding areas until they are approaching breeding age.

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OSPREY
Pandion haliaetus

VARIATION Occurs as nominate *haliaetus* in the region, but resident birds from the Red Sea and Arabia may warrant taxonomic recognition (as 'Arabian Osprey'). They are whiter and less marked below and the upperparts are often heavily worn and bleached as a result of exposure to intense sunlight and flying sand. There are two records of the North American ssp. *carolinensis* from the region (Iceland and the Azores; Strandberg 2013).

DISTRIBUTION Cosmopolitan, with a nearly worldwide distribution. In our region confined to temperate parts of W, C and N Europe, with additional populations in Arabia, the Red Sea, W Mediterranean, Portugal and on some Atlantic islands. Reintroduced and now breeding again in S Spain.

BEHAVIOUR Often seen hovering over shallow waters, both salty and fresh, looking for fish. Perches prominently on posts and tops of dead trees; often also on rocks by the water.

MOULT The adults moult in the breeding area as well as on the wintering grounds, with moult suspended for the migration. Adults can thus be growing flight feathers during any month of the year.

The Osprey is the only species in the region, except for Black-shouldered Kite, to start its complete wing-moult in its 1st cy. By late Nov–Dec migrant juveniles start their wing-moult by dropping their innermost primary, after which the moult is a more or less continuous process for the rest of the bird's life, save for temporary stops during migration and part of breeding season. Resident populations of the Red Sea and Arabia moult c. 4–6 months earlier in the season compared to migratory populations, mirroring their earlier breeding season. Juveniles of the Arabian population moulting for the first time can thus be told from migrant juveniles wintering in the same area by their more advanced moult at any given date.

SPECIES IDENTIFICATION A rather straightforward species to identify, thanks to its diagnostic plumage and shape, and limited plumage variation. Even from a distance, or in poor light, when the underwings may look just dark, the white body and head in combination with the diagnostic, long and narrow, clearly angled wings and rather short and narrow tail are enough to identify an Osprey. Powered flight with wings pushed forward and angled at the carpal, with most of wing-action typically occurring below horizontal level. Glides with wings smoothly arched, reminiscent of large gull.

PLUMAGES Normally only two plumages can be separated in the field, juveniles and adults, although, given good views, a transitional plumage can also be recognised by its retained juvenile secondaries. Owing to the strong wear and bleaching of the upperside, juveniles already lose their distinctive pale feather tips during their first winter, becoming much more difficult to separate from older birds by spring.

Juvenile

Fresh autumn juveniles are slimmer in outline than adults, with narrower wings in particular. Seen against a dark backdrop the white trailing edge to the wings and the white tail-tip are diagnostic as is the distinct pale scaling of the dark upperparts, although this is often difficult to discern from any distance, except for a wider whitish elbow-patch, which is visible from afar on the inner upperwing.

Seen from below, the barring of tail and remiges differ from that of the adults by being more distinct and even, and also by the lack of a broad subterminal band. The greater underwing-coverts are clearly barred, compared with the dark-looking greater coverts of adult birds, which combines to give the whole underwing a lighter and more distinctly and loosely patterned appearance. The white forearm is stained yellowish-buff, a further difference from the adults. The crown is dark-streaked in juveniles and the dark breast-band, when present, appears scaly, although this is discernible only at close range. Iris is orange, not light yellow as in adult.

Transitional plumage

The pale tips and margins of the upperparts soon wear off, and may be lost already by Nov in the 1st cy. At the same time the moult of the primaries also starts. First-winter birds would thus be moulting their inner primaries, while the rest of the plumage remains juvenile. Immatures can be aged well into their first moult by their remaining juvenile secondaries and greater underwing-coverts, showing the juvenile-type barring (see under Juvenile above). Also the pale tips of the upper primary coverts are often retained until later, giving a clue about the bird's age. As long as juvenile secondaries are retained, the immatures can be aged by the diagnostic barring of the juvenile feathers, but by late 2nd cy autumn at least some birds would probably have replaced all their juvenile remiges, making exact ageing impossible.

Adult

Adults are uniformly brown above, save for irregularities owing to variously worn feathers, the crown is shining white and the tail, when fanned, is darker in the middle while the paler sides show rather distinct sparse barring and a broad diffuse darker subterminal band ('wheatear-pattern'). Seen from below the body is gleaming white, with a variably clear, darker breast-band (see under Sexing). The underwing has a diagnostic and constant pattern, with white forearm, a darker line of greater coverts and a rectangular dark carpal patch. The flight feathers are brownish-grey with rather faint barring, the tips of the long primaries being darkest. The darker tips of the secondaries create a broad but faint dark trailing edge to the arm and the greater underwing-coverts appear all-dark, both features different from the juvenile plumage.

SEXING Often possible but since many of the characters are overlapping, multiple features need to be seen. The white forewing looks clean in males, with at the most just one row of small dark spots, while females often show several lines of bigger spots; the underwing thus looks more 'messy' compared to males. In males, the dark carpal patch is restricted mostly to the forewing, while in females it also stretches to the greater coverts. As a rule, males have a paler and less conspicuous breast-band than females, but difficult intermediates occur. Males are also slimmer in silhouette than females, with narrower wings and a slimmer body, and the head is rounder and bill smaller, but appreciating these differences requires former experience or a chance to compare the two side-by-side. Juveniles can be sexed following the principles given above, but the differences may be less pronounced.

CONFUSION RISKS Not possible to mistake for any other raptor when seen well, thanks to diagnostic shape, with long narrow and angled wings and distinct plumage. The Osprey is the only raptor which, from a distance, is vaguely reminiscent of a large gull.

NOTE The population of Arabia and the Red Sea breeds up to six months earlier in the season compared to the migratory birds from further north, hence their moult also starts earlier in the year. Apart from being overall whiter and less marked below, they are also more heavily worn and more bleached above compared to migrants from the north, which may occur in the same area on migration and in winter. This difference in plumage condition is particularly obvious in young birds during autumn and first winter, when migrants appear in a fairly good plumage while the local birds are extremely faded and worn. By the time the migrant juveniles commence their first moult the local birds' moult is already well underway, showing up to 4–5 fresh inner primaries.

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1. Osprey *Pandion haliaetus*, adult female on migration, showing typical silhouette of the species, with long, narrow, distinctly bent wings and rather small tail. White body and wing linings, together with dark carpals, greater coverts and outer hand, make the species rather unmistakable. Israel, 25.3.2013 (DF)

2. Osprey *Pandion haliaetus,* juvenile male, wintering. Aged as a juvenile by yellowish wash to underwing-coverts, distinct and uniform barring of secondaries, and streaked crown; identified as a male by slim build, faint breast-band and clean underwing-coverts. Oman, 7.11.2013 (DF)

3. Osprey *Pandion haliaetus,* juvenile (male), wintering. Note more distinctly barred secondaries and more loosely patterned greater coverts compared to adult. Weak breast-band, clean wing-coverts and small, broken carpal patch indicate a male. Oman, 7.11.2013 (DF)

4. Osprey *Pandion haliaetus,* juvenile female, wintering. Females are broader-winged, heavier-bodied and stronger-billed than males, even as juveniles. Note also more distinct breast-band and spotted wing-linings of female, and compare with **2**. Oman, 12.11.2013 (DF)

5. Osprey *Pandion haliaetus,* juvenile female, wintering (same as **4**). Fresh juveniles feature pale feather-tips on entire upperparts. Oman, 12.11.2013 (DF)

6. Osprey *Pandion haliaetus,* juvenile of the resident Arabian population. Note whiter crown and poorly defined dark eye-mask but, above all, the heavily worn plumage; compare with the wintering migrant in **4**, photographed only three days later. Inner primaries and central tail are moulting. Oman, 9.11.2013 (DF)

7. Osprey *Pandion haliaetus,* juvenile of the resident Arabian population. Note pale overall impression with poorly defined dark carpal patch. Oman, 21.11.2014 (DF)

8. Osprey *Pandion haliaetus,* juvenile of the resident Arabian population (same as **7**). Extremely worn plumage is typical of autumn juveniles of this population; note advanced moult compared to migrant juveniles. Oman, 21.11.2014 (DF)

9. Osprey *Pandion haliaetus,* juvenile female, wintering. Moult of inner primaries and central tail has commenced, but timing is about three months later compared to locally bred juveniles (cf. **6**). Note distinct breast-band, spotted underwing-coverts and solid dark carpal area, indicative of a female. Oman, 15.2.2013 (DF)

10. Osprey *Pandion haliaetus,* juvenile male, wintering. Primary moult has only just commenced; sexed by clean underwing-coverts. Oman, 10.2.2014 (DF))

11. Osprey *Pandion haliaetus,* first-winter juvenile (migrant?). Compare pattern of retained juvenile and moulted adult-type secondaries, and note scaly appearance of breast-band, typical of a juvenile. Israel, 28.3.2012 (DF)

12. Osprey *Pandion haliaetus,* adult male, breeding. Diffuse breast-band and white underwing-coverts suggest male, as does the shape of the carpal patch, being darkest along the leading edge of the wing. Finland, 20.4.2013 (DF)