Raptor Identification, Ageing, and Sexing

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To successfully conduct raptor research or, indeed, any ornithological research, researchers must be able to identify their subjects accurately to species and, in many studies, determine their age and sex. This is true for (1) field studies, including observations and counts, (2) capture for ringing (i.e., banding), color marking, and radio tracking and telemetry, and (3) the examination and measurement of museum specimens.

Identification is more difficult for Falconiformes than for Strigiformes, as there are more species (more than 300 Falconiformes versus about 200 Strigiformes) and more variation in plumages within species. Most of this chapter applies to diurnal raptors. The following paragraphs discuss plumages, including field marks and unusual plumages; field guides, with cautions about their use; the use of molt as a tool in ageing; the use of behavior in field identification; and a section on identification in the hand. Important references are listed at the end of the chapter.

INITIAL POINTERS

Accurate Identification is Critical

The validity of the results and conclusions of any raptor research depends upon the accurate identification of the subjects involved. Therefore, workers must acquire or sharpen their skills in species identification, including sexing and ageing, to produce the best research. Fortunately, for some researchers, good bird field guides, often including field and photo guides specifically for raptors, as well as an ever-growing list of published articles on identification, ageing, and sexing of raptors, are readily available.

Why Are Raptors Difficult to Identify?

Diurnal raptors are difficult to identify because most species have a variety of plumages, including different plumages for immatures, sexes, and color morphs; and many exhibit considerable individual variation. Many of these plumages are similar to those of other species. Another cause of difficulty is that many bird field guides don't show the range of variation in plumages, don't include the latest information regarding important field marks, and don't portray the shapes of flying and perched raptors accurately. This is true even in an era with access to many wonderful photographs.

Optical and Photographic Equipment

We now have better binoculars, telescopes, and cameras to aid our raptor research. Although some researchers are not able to afford top-of-the-line equipment, lower priced equipment is often very good and adequate for most research needs. Thus, researchers are able to get much better views of their subjects and use more subtle field marks to identify them and determine age and sex. Also, we can take high-quality photographs of raptors, especially in those cases where the identification could not be made in the field. Raptor researchers are urged to always bring their cameras in the field with them so that they can photograph raptors of questionable identification for later verification. More than once, I have changed the identification of a raptor after viewing photographs of them later.

FIELD IDENTIFICATION

The topics below should be read and studied to better understand how to identify raptors correctly under field conditions.

Age Terminology

Use of proper age terminology helps us to understand molt, plumages, and ageing. The best age terminology is one that corresponds one-to-one with annual changes in plumage; those that change with the calendar year are confusing because the age of the bird changes on 1 January, but the bird does not change in appearance.

Nestlings begin with two sets of down, descriptions of which are not within the scope of this chapter. While still in the nest, young raptors acquire their first, or juvenal plumage (note that the spelling is *juvenal* plumage in North America and *juvenile* plumage elsewhere). In most species, juvenal plumage is worn for 7 months to almost a year. In temperate regions, raptors typically fledge in summer and begin the molt from their juvenal plumage into their second plumage the next spring. In tropical areas, this molt usually begins 8 or 9 months after fledging, which can be at any month of the year depending on the timing of breeding and is usually determined by the timing of regional wet and dry seasons.

Depending on the size of the raptor, annual molt takes between 3 and 10 months to complete. In some species, usually the smaller ones, the resulting plumage is the adult or Definitive Basic plumage (Humphrey and Parks 1959). Most falcons have only one immature or juvenal plumage. Many accipitrid raptors, especially larger buzzards, vultures, and eagles, however, have more than one immature plumage. In North America, the latter immature plumages are called Basic I, then Basic II, etc. until Definitive Basic (Adult) plumage is achieved (Humphrey and Parks 1959). Howell et al. (2003) refers to the latter immature plumages as Basic II, Basic III, etc. In other geographic areas, most call them Second plumage, Third plumage, etc. The second and subsequent plumages are acquired by annual molts. Note that many field guides and authors use the term immature for juvenile. The term subadult has been used to refer to at least three different age categories. The use of subadult should be avoided.

Field Marks

Field marks are the characters of a bird, in our case, a raptor, that can be used by the observer to identify it to species and, often, its age and sex. Field marks include plumage characters such as the white head and tail of adult Bald Eagles (*Haliaeetus leucocephalus*), the wide white line running through the underwings of immature Steppe Eagles (*Aquila nipalensis*), or the bold black-and-white plumage of adult male Pied Harriers (*Circus melanoleucus*). For most raptors, more than one field mark is needed for identity, and the more field marks correctly seen, the more certain the identity. Other field marks are the shape and length of wings and tail on soaring raptors (Fig. 1), head projection beyond the wings on flying raptors, and, for many species, the positions of the wing tip relative to the tail tip on perched raptors (Fig. 2). Wing attitude of soaring and gliding raptors also can be field marks, along with behavior patterns, such as kiting and hovering or the wing flex of vultures. Some field marks, such as pale wing panels, are useful only on flying individuals, whereas the color of the shoulders can apply only to perched individuals.

Field Guides

Field guides, especially raptor field guides and photo guides, are one of the best sources for field marks used to identify raptors in the field. Unfortunately, many of the general bird guides are inadequate for raptors, although they are useful for most other species of birds. Bird guides often contain errors in age and sex characteristics, fail to show the range of variation in plumages, and incorrectly depict the shape of flying and perched individuals. That said, some of the newer bird field guides, including Hollom et al. (1988), Fjeldså and Krabbe (1990), Jonsson (1993), Zimmerman et al. (1996), Mullarney et al. (1999), Sibley (2000), and Rasmussen and Alderton (2005), depict wing and tail shapes correctly, and their perched raptors look like their real-life subjects. Additional general bird guides, including Barlow and Wacher (1997), Grimmett et al. (1999), and Stevenson and Fanshawe (2002), adequately describe plumage and field marks, but don't depict wing, tail, and body shapes correctly.

Figure 1. Adult Verreaux's Eagle (*Aquila verreauxii*). Wing shape is an important field mark, as shown on this African eagle. *(W.S. Clark, Kenya)*

Figure 2. Adult Peregrine Falcon (*Falco peregrinus*). In the Americas, the Peregrine Falcon is the only falcon that, when perched, shows wingtips reaching the tail tip. *(W.S. Clark, Saskatchewan)*

On the other hand, many raptor guides vary from very good to excellent. The very first field guide to show accurate wing and tail shapes in flight was *Flight Identification of European Raptors* (Porter et al. 1981). The authors, including the artist, are to be commended for this classic work. Although this guide is somewhat out of date, does not include perched raptors, and has only black-and-white drawings and photos, it is highly recommended. Following the lead of Porter et al. (1981), other raptor field and photo guides include Wheeler and Clark (1995), Morioka et al. (1995), DeBus (1998), Forsman (1999), Clark (1999a), Clark and Wheeler (2001), Coates (2001), Wheeler (2003a,b), and Ligouri (2005). Two other photo guides with good photos, but little information are Allen (1996) and Kemp and Kemp (1998).

The two most recent global handbooks for raptors, del Hoyo et al. (1994) and Ferguson-Lees and Christie (2001), have some information on raptor identification, but their illustrations were produced primarily from museum specimens, often with simplistic "cookie cutter" wing and body shapes that don't resemble their real-life counterparts. The new world raptor field guide by the latter authors (Ferguson-Lees and Christie 2005) uses most of the same museum-specimen plates. Several continental handbooks, including Cramp and Simmons (1980) for Europe, Palmer (1988) for North America, and Marchant and Higgins (1993) for Australia, contain much information and useful illustrations on raptor identification.

Other important sources of information for field identification include the many articles on the subject that have appeared in the peer-reviewed literature. There are too many of these to list all of them, but examples include Watson (1987), Brown (1989), Clark and Wheeler (1989, 1995), Clark et al. (1990), Shirihai and Doherty (1990), Clark and Schmitt (1993, 1998), Clark and Shirihai (1995), Debus (1996), Forsman (1996a,b), Alström (1997), Forsman and Shirihai (1997), Corso and Clark (1998), Clark (1999b), Corso (2000), and Rasmussen et al. (2001).

Methods of Flight

Raptors use one of four methods for flying. Recognizing which method they are using is important in identification. Raptors soar to gain altitude in rising air, usually in a thermal or a deflection updraft. When soaring, their wings are spread to the maximum with outer primaries often recognized as fingers and often with wrists pushed forward somewhat. Their tails also are usually spread. The shape of soaring raptors is constant and is an excellent field mark. Further, when they are in a thermal or deflection updraft, they are usually visible for some time, aiding in their identification. Birds in soaring flight should be, and in many cases are, depicted in field guides. Gliding is used by raptors to travel overland after they have gained height. In gliding flight, a raptor's wrists are pushed forward more and their wingtips are pulled back from the soaring position, such that they are somewhat more pointed and don't show fingers. The amount to which the wings are pulled back varies with the angle of glide, from slightly in a shallow glide, which is most often used by migrating raptors, to almost completely folded to the body in hunting raptors that are stooping on potential prey. Hovering and kiting are additional methods of flight that are used by some raptors for hunting. In both flight patterns the bird is fixed over ground or water while looking for prey. Hovering, which is more properly called wind hovering, occurs when a raptor faces into the wind and flaps its wings to remain in the same place. Kiting is when the raptor does not flap but holds its wings steady to remain in the same position. Not all raptors hover and kite, and flight behavior itself can be used to help identify a raptor to species. Flapping or powered flight is used to move from one place to another, often when thermals and deflection updrafts are not available. The wing-beat rate can be used to indicate size, with larger raptors beating their wings more slowly than smaller raptors. Some species can be identified by the shape of the wingtips at the apex and nadir of the wing strokes. The Northern Goshawk (*Accipiter gentilis*), for example, shows very pointed wingtips in powered flight.

Variation in Appearance Due to Light Conditions

Raptors and other birds usually appear differently under the varying light conditions that occur throughout the day and the year and during different weather conditions (e.g., sunny, overcast, and rainy periods). Far too little has been written about this variation and its effect on field marks. For example, the sun gives a reddish cast to pale areas on birds early and late in the day. In mid-day, especially when it is sunny and the ground is reflective, snow or pale desert, the reflected light allows better definition on underwings and undertails of flying raptors. When the surface is dark grass or forest, much less light is reflected and the underwing and undertail appear much darker. Wet birds and those flying against overcast, whitish skies have an overall darker appearance.

Size

Although many believe that it is possible to do so, humans are not capable of judging the size of singly flying raptors accurately. Thus, size of a raptor flying by itself is not a field mark. However, the relative sizes of two or more raptors or a raptor and another bird, such as a Common Raven (*Corvus corax*), flying together can be used successfully, as we can judge relative sizes.

Distance

Raptors flying at a distance are hard to identify because their field marks, especially colors, are difficult to discern, and because their plumage appears more black or white.

Jizz

Jizz is use of subconscious clues to identify raptors and other birds, usually at a distance when field marks are not visible. The term is thought to come from the phrase "General impression, size and shape," and most likely was coined during World War II to describe the technique used to distinguish aircraft flying to England from the continent. Dunne et al. (1988) describe the method in more detail for North American raptors. Accuracy in identification by JIZZ depends on the experience and skill level of the observer and, in most cases, is much less than that derived from the use of standard field marks.

Flight-Feather Molt

Accipitrid raptors molt their primary feathers beginning at P1 (innermost), with the molt proceeding outward sequentially to the outermost primary, P10 (Edelstam 1984). They molt their secondary feathers beginning at three molt centers, S1 (outermost), S5, and S12 in the smallest hawks to S22 on large vultures (Miller 1941). Molt proceeds sequentially inward from S1 and S5 and outward from the innermost center.

Primary molt of falconid raptors begins at P4 and proceeds both outward and inward sequentially to P10 and P1, respectively. Their secondary molt begins at S5 and proceeds sequentially inward and outward to inner secondary and S1, respectively (Edelstam 1984).

Rectrix (i.e., tail-feather) molt in raptors begins almost always with T1 (the central or deck feathers). There is a great deal of variation in the order of replacement, although T2 and T6 are usually replaced next. While T5 is the last to be replaced in some species, T4 is the last replaced in others. Asymmetry occurs more often in tail-feather than in wing-feather molt.

The wing and tail molt of all falconid raptors, and that of smaller accipitrid raptors, usually is complete (i.e., occurs within a single year), and subsequent molts in subsequent years typically begin at the same molt centers. However, larger accipitrid raptors don't complete wing molt annually, and many don't complete the tail molt annually, either. (See below for the use of incomplete molt in ageing immatures in these species.)

Body Feather and Covert Molt

Molt of body feathers begins slowly for juveniles of many species not long after fledging. Pyle (2005) describes this process as "pre-formative molt." Molt begins actively 7 to 10 months after fledging, starting at the head and proceeding down the neck and through the body caudally. Wing- and tail-covert molt begins after body-feather molt is well underway. Body feather and covert molt is complete for all but the larger species. Even so, a few feathers may not be replaced every year, particularly among the uppertail or upperwing coverts.

Molt and Its Use in Ageing

Molt of flight feathers can be an aid in determining the age of immatures of species that take more than one year of molt to attain adult plumage. This is true for most of the larger accipitrid raptors. Although not all primaries are replaced annually in these raptors, P1 is always replaced annually. Thus, molt can occur simultaneously in two to three locations in these feathers (Clark 2004a). Juveniles show no molt (Fig. 3a). Second-plumage raptors (Basic II) have new inner primaries and old, retained juvenile outer primaries (Fig. 3b). Third-plumage raptors show two "waves" of molt, with new inner primaries and new outer primaries, with retained juvenile P10 in most large eagles (Fig. 3c). In some raptors, this is adult plumage, but in others, especially large eagles, body and tail feathers are still immature at this time. Fourth plumage in most eagles begins to resemble adult plumage, but with noticeable immature characters. The primary molt is like that of adults, with three waves of primary molt (Fig. 3d). Secondary

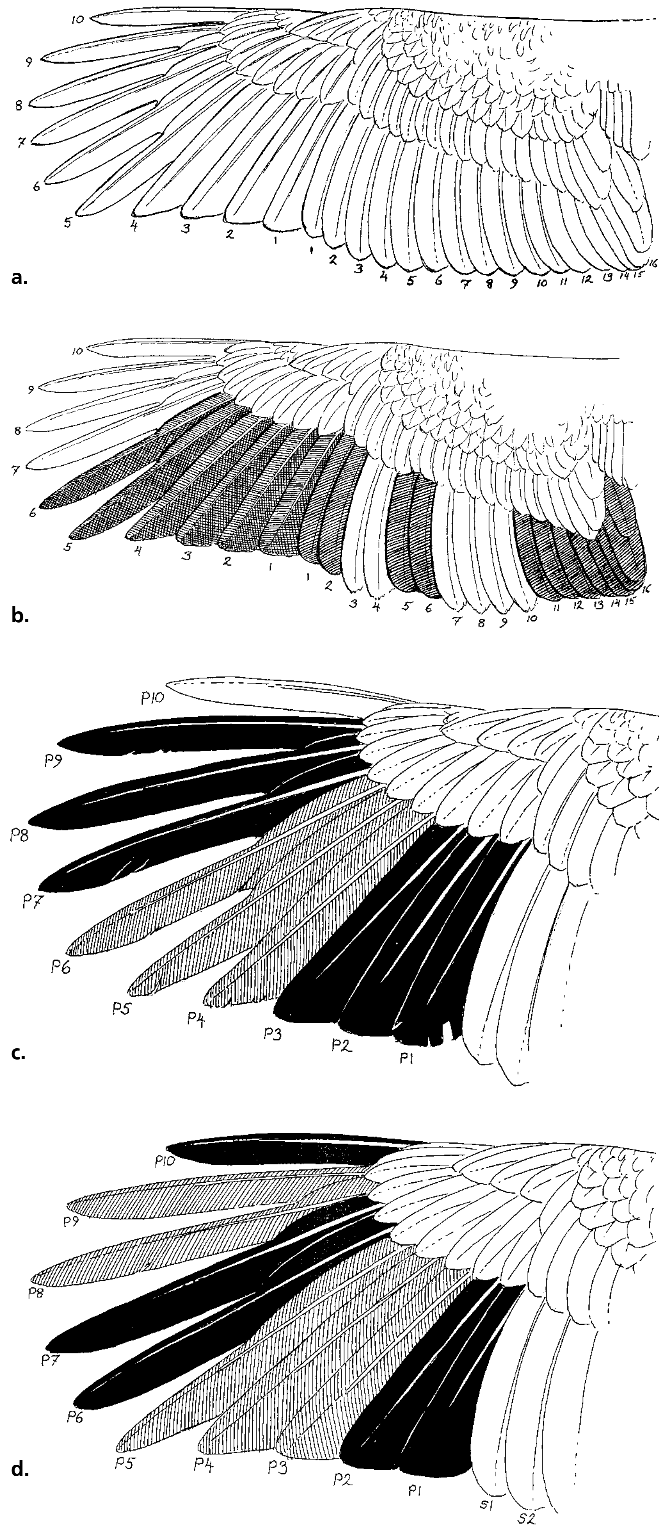

Figure 3. a. Juvenile remiges. Juveniles show no obvious molt; all feathers are the same age and show the same amount of wear. Secondaries have rather pointed tips. **b.** Second plumage (Basic II). Inner primaries have been replaced in sequence P1 outwards, and outer ones are retained juvenile. New secondaries of eagles are shorter than those of juveniles (but see Fig. 4). **c.** Third plumage (Basic III). First wave of molt has progressed to P9 and second wave to P3. **d.** Adult. Adults show from two to four waves of primary molt.

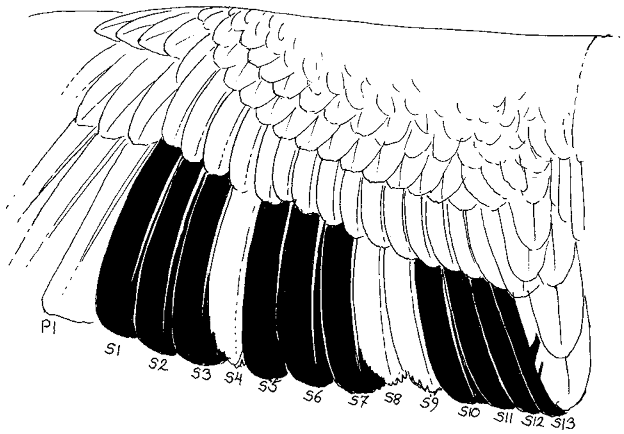

Figure 4. New secondaries of some raptors (e.g., Buteos) are longer than juvenile ones.

molt is useful for ageing immatures of larger accipitrid raptors, with juveniles showing no molt. The secondaries of juveniles are distinctive with pointed, narrower tips than those of subsequent plumages; the new secondaries are shorter than the juvenile ones in some species (e.g., eagles [Fig. 3a]), but are longer in others (e.g., Buteos [Fig.4]). In a few species the new and juvenile secondaries are the same length. In the second plumage, the secondaries are a mix of new feathers and old retained juveniles feathers (Fig. 4). Third-plumage eagles usually show all non-juvenile feathers, but occasionally S4, S8, or S9, or some combination of these, are not replaced. In some species, especially eagles, the tail feather pattern varies with each age and can be used for ageing. Best results are obtained by using field marks in the molt of all three feather types: primary, secondary, and tail.

Pyle (1997) describes molt in owls.

Unusual Plumages

Besides individual variation, raptors can show abnormal plumages, especially partial albinism, dilute plumage (also called leucism or shizochronism), and melanism, including erythrism. There are few, if any, records of complete albinism in raptors. Partial albinos however, occur regularly, especially in some species such as the Red-tailed Hawk (*Buteo jamaicensis*) (Wheeler and Clark 1995, Clark and Wheeler 2001). Individuals so affected show a variable number of all-white feathers, from few to almost all; and most show pigment in the eyes, cere, and beak, but often lack it in the talons. A similar pale condition, dilute plumage, occurs when most to all of their feathers have a reduced amount of dark pigmentation (melanin); usually dark brown feathers then appear much paler, even tawny, or "café-au-lait." At the opposite extreme, a few individuals exhibit an excess of pigmentation, resulting in a darker bird overall. In some species, especially buzzards, where it occurs regularly, individuals with this condition are referred to as "dark morphs." In species lacking regular dark morphs, the condition is usually referred to as melanism, to indicate that it is an aberrant plumage that is not usually passed on genetically (e.g., see Clark 1998 for Ospreys [*Pandion haliaetus*]). Erythrism, in which there is an excess of the reddish pigment, erythrin, also occurs in raptors but much less often than melanism.

Range Maps

Range maps in field guides and handbooks should be used with caution, as they have major limitations. They don't show density information, nor do they show habitat preferences. Also, they offer no information on whether a species is detected easily. Lastly, ranges of birds are dynamic and change over time, especially with changing land use. Range maps in regional or smaller area guides and handbooks can be more useful, at least compared with continent-wide guides and handbooks.

In-hand Identification

In many field activities it is necessary to have the raptors in hand (e.g., banding or ringing, attaching radio or satellite transmitters for telemetry, taking measurement data, collecting blood or feather samples for analysis), or a combination of these, and other reasons. Hand-held raptors should be easier to identify, age, and sex than those spotted in the field (Fig. 5). One can see plumage details well and take measurements, which is especially helpful in determining sex. Most bird and raptor field and photo guides are generally sufficient for in-hand identification. Even so, several specialty, in-hand guides for raptors have been published, including Baker (1993) for Europe and Clark and Yosef (1998) for the Middle East. In North America, the Bird Banding Lab maintains a downloadable manual for ageing and sexing raptors by Hull and Bloom (2001) at www.pwrc.usgs.gov/bbl/resource.htm. Several raptor banding stations, including the Golden Gate Raptor Observatory in California (www.GGRO.org), have their own raptor in-hand identification, ageing, and sexing manuals (Culliney and Hull 2005).

Figure 5. Adult Common Buzzard (*Buteo buteo buteo*). Raptors in hand can more easily aged and sexed by measurements, molt, and plumage. *(W.S. Clark, Israel)*

There also are many articles on ageing individual species of raptors in-hand, including the Bald Eagle (Clark 2001), Egyptian Vulture (*Neophron percnopterus*) (Clark and Schmitt 1998), White-tailed Hawk (*B. albicaudatus*)(Clark and Wheeler 1989), Roughleg (*B. lagopus*) (Clark and Bloom 2005), Steppe Eagle (Clark 1996), Asian Imperial Eagle (*A. heliaca*) (Clark 2004b), Golden Eagle (*A. chrysaetos*) (Bloom and Clark 2001), as well as others on sexing individual species of raptors, including Bald Eagle (Bortolotti 1984a), and Golden Eagle (Bortolotti 1984b).

Figure 6. Juvenile Snowy Owls (*Bubo scandiaca*). Bird field guides are sufficient for identification of owls. Sexes of Snowy Owls differ in plumage, with juvenile females (left) being more heavily marked than males (right). *(W.S. Clark, British Columbia)*

Ageing and Sexing Owls

Plumage differences can be used to age and sex some species of owls (Fig. 6). Pyle (1997) uses plumage differences and measurements to sex several North American owls and molt of flight feathers to age them. David Brinker has developed a discriminate function analysis for sexing Northern Saw-whet Owls (*Aegolius acadicus*) that is available on-line at www.projectowlnet.org.

Sound Recordings

Field studies on raptors sometimes involve using recorded vocalizations to bring individual birds closer to the observer or to verify their identification. Professional quality recordings of raptor vocalizations can be purchased from the Macaulay Library at the Cornell Lab of Ornithology (www.birds.cornell.edu/macaulay library) or the Borror Laboratory of Bioacoustics at The Ohio State University (blb.biosci.ohio-state.edu). Both labs have a searchable database of recordings on their websites. A search on Google™ of "Bird sound recordings" also can be useful.

ON-LINE REFERENCES

The Internet is an excellent source of raptor ID references and raptor images. Particularly useful sites include:

(1) SORA (Searchable Ornithological Research Archive), an open access electronic journal archive and the product of collaboration between ornithological organizations and the University of New Mexico libraries and IT department, at http://elibrary.unm.edu/sora. The

archive provides access to back issues of *The Auk* (1884–1999), *The Condor* (1899–2000), *Journal of Field Ornithology* (1930–1999), *The Wilson Bulletin* (1889–1999), *Pacific Coast Avifauna* (1900–1974) and *Studies in Avian Biology* (1978–1999).

(2) The Global Raptor Information Network (GRIN) provides information on diurnal raptors (hawks, eagles, and falcons) and facilitates communication between raptor researchers and organizations interested in the conservation of these species. This site also includes information on identifying species of raptors (www.globalraptors.org/grin/indexAlt.asp).

(3) The Raptor Information System is a key-worded catalog of over 40,000 references about the biology, management, and identification of birds of prey (http://ris.wr.usgs.gov).

(4) Ornithological Worldwide Literature (OWL) is a compilation of citations and abstracts from the worldwide scientific literature about owls that includes information on identification. The site includes considerable coverage of the "gray literature," much of which is not abstracted in commercial databases (http://egizoosrv.zoo.ox.ac.uk/owl).

(5) Hawk wing photos. The University of Puget Sound provides photos of the spread underwings of specimens at www.ups.edu/biology/museum/wings_Accipitridae.html.

The journal *North American Bird Bander* also will be available online soon.

SUMMARY

Accurate identification of raptors is key to successful raptor research. Recent advances and improvements in optics, together with increased knowledge of raptor field marks for species identification, as well as for ageing and sexing within species, continue to make this increasingly possible for most species of birds of prey.

LITERATURE CITED

ALLEN, D. 1996. A photographic guide to birds of prey of southern, central, and East Africa. New Holland, Cape Town, South Africa.

ALSTRÖM, P. 1997. Field identification of Asian *Gyps* vultures. *Orient. Bird Club Bull.* 25:32–49.

BAKER, K. 1993. Identification guide to European non-passerines: BTO Guide 24. British Trust for Ornithology, Thetford, United Kingdom.

BARLOW, C. AND T. WACHER. 1997. A field guide to birds of The Gambia and Senegal. Pica Press, Robertsbridge, United Kingdom.

BLOOM, P. AND W. S. CLARK. 2001. Molt and sequence of plumages of Golden Eagles, and a technique for in-hand ageing. *N. Am. Bird Band.* 26:97–116.

BORTOLOTTI, G.R. 1984a. Sexual size dimorphism and age-related size variation in Bald Eagles. *J. Wildl. Manage.* 48:72–81.

———. 1984b. Age and sex size variation in Golden Eagles. *J. Field Ornithol.* 55:54–66.

BROWN, C.J. 1989. Plumages and measurements of Bearded Vultures in Southern Africa. *Ostrich* 60:165–171.

CLARK, W.S. 1996. Ageing Steppe Eagles. *Birding World* 9:269–274.

———. 1998. First North American record of a melanistic Osprey. *Wilson Bull.* 110:289–290.

———. 1999a. A field guide to the raptors of Europe, the Middle East, and North Africa. Oxford University Press, Oxford, United Kingdom.

———. 1999b. Plumage differences and taxonomic status of three similar *Circaetus* snake-eagles. *Bull. Br. Ornithol. Club* 119:56–59.

———. 2001. Aging Bald Eagles. *Birding* 33:18–28.

———. 2004a. Wave molt of the primaries of accipitrid raptors, and its use in ageing immatures. Pages 795–804 *in* R.D. Chancellor and B.-U. Meyburg [EDS.], Raptors Worldwide. World Working Group on Birds of Prey and Owls, Berlin, Germany.

———. 2004b. Immature plumages of the Eastern Imperial Eagles *Aquila heliaca*. Pages 569–574 *in* R.D. Chancellor and B.-U. Meyburg [EDS.], Raptors Worldwide. World Working Group on Birds of Prey and Owls, Berlin, Germany.

CLARK, W.S. AND P.H. BLOOM. 2005. Basic II and Basic III plumages of Rough-legged Hawks. *J. Field Ornithol.* 76:83–89.

——— AND N. J. SCHMITT. 1993. Field identification of the Rufous-bellied Eagle. *Forktail* 8:7–9.

——— AND N.J. SCHMITT. 1998. Ageing Egyptian Vultures. *Alula* 4:122–127.

——— AND H. SHIRIHAI. 1995. Identification of Barbary Falcon. *Birding World* 8:336–343.

——— AND B.K. WHEELER. 1989. Field identification of the White-tailed Hawk. *Birding* 21:190–195.

——— AND B.K. WHEELER. 1995. The field identification of Common and Great Black Hawks. *Birding* 27:33–37.

——— AND B.K. WHEELER. 2001. A field guide to hawks of North America, 2nd Ed. Houghton Mifflin Co., Boston, MA U.S.A.

——— AND R. YOSEF. 1998. In-hand identification guide to Palearctic raptors. International Birdwatching Center - Eilat, Eilat, Israel.

———, R. FRUMKIN, AND H. SHIRIHAI. 1990. Field identification of the Sooty Falcon. *Br. Birds* 83:47–54.

COATES, B.J. 2001. Birds of New Guinea and the Bismarck Archipelago. Dove Publications, Alderley, Australia.

CORSO, A. 2000. Identification of European Lanner. *Birding World* 13:200–213.

——— AND W.S. CLARK. 1998. Identification of Amur Falcon. *Birding World* 11:261–268.

CRAMP, S. AND K.E.L. SIMMONS. 1980. The Birds of the Western Palearctic, Vol. 2. Oxford University Press, Oxford, United Kingdom.

CULLINEY, S. AND B. HULL. 2005. GGRO Banders' Raptor Identification Guide, 2nd Ed. Golden Gate Raptor Observatory, San Francisco, CA U.S.A.

DEBUS, S.J.S. 1996. Problems in identifying juvenile Square-tailed Kite. *Aust. Bird Watcher* 16:260–264.

———. 1998. The birds of prey of Australia: a field guide to Australian raptors. Oxford University Press, South Melbourne, Australia.

DEL HOYO, J., A. ELLIOTT, AND J. SARGATAL [EDS.]. 1994. Handbook of the Birds of the World, Vol. 2. Lynx Edicions, Barcelona, Spain.

DUNNE, P., D.A. SIBLEY, AND C. SUTTON. 1988. Hawks in flight. Houghton Mifflin Company, Boston, MA U.S.A.

EDELSTAM, C. 1984. Patterns of moult in large birds of prey. *Ann. Zool. Fenn.* 21:271–276.

FERGUSON-LEES, J. AND D.A. CHRISTIE. 2001. Raptors of the world. Houghton Mifflin Co., Boston, MA U.S.A.

——— AND D.A. CHRISTIE. 2005. Raptors of the world. Princeton University Press, Princeton, NJ U.S.A.

FJELDSÅ, J. AND N. KRABBE. 1990. Birds of the high Andes. Zoological Museum, University of Copenhagen and Apollo Books, Copenhagen and Svendborg, Denmark.

FORSMAN, D. 1996a. Identification of Spotted Eagle. *Alula* 2:16–21.

———. 1996b. Identification of Lesser Spotted Eagle. *Alula* 2:64–67.

———. 1999. The raptors of Europe and the Middle East. T. & A.D. Poyser Ltd., London, United Kingdom.

——— AND H. SHIRIHAI. 1997. Identification, ageing and sexing of Honey-buzzards. *Dutch Birding* 19:1–7.

GRIMMETT, R., C. INSKIPP, AND T. INSKIPP. 1999. A guide to the birds of India, Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives. Princeton University Press, Princeton, NJ U.S.A.

HOLLOM, P.A.D., R.F. PORTER, S. CHRISTENSEN, AND I. WILLIS. 1988. Birds of the Middle East and North Africa: a companion guide. T. & A.D. Poyser Ltd., Calton, United Kingdom.

HOWELL, S.N.G., C. CORBIN, P. PYLE, AND D.I. ROGERS. 2003. The first basic problem: a review of molt and plumage homologies. *Condor* 105:635–653.

HULL, B. AND P.H. BLOOM. 2001. The North American banders' manual for raptor banding techniques. North American Banding Council, Patuxent, MD U.S.A.

HUMPHREY, P.H. AND K.C. PARKES. 1959. An approach to the study of molts and plumages. *Auk* 76:1–31.

JONSSON, L. 1993. Birds of Europe. Princeton University Press, Princeton, NJ U.S.A.

KEMP, A. AND M. KEMP. 1998. Birds of prey of Africa and its islands. New Holland, London, United Kingdom.

LIGUORI, J. 2005. Hawks from every angle: how to identify raptors in flight. Princeton University Press, Princeton, NJ U.S.A.

MARCHANT, S. AND P.J. HIGGINS. 1993. Handbook of Australian, New Zealand, and Antarctic birds. Oxford University Press, Melbourne, Australia.

MILLER, A.H. 1941. The significance of molt centers among the secondary remiges in the Falconiformes. *Condor* 43:113–115.

MORIOKA, T., N. YAMAGATA, T. KANOUCHI, AND T. KAWATA. 1995. The birds of prey in Japan. [In Japanese with English summaries.] Bun-ichi Sogu Shuppan Company, Tokyo, Japan.

MULLARNEY, K., L. SVENSSON, D. ZETTERSTROM, AND P. GRANT. 1999. Birds of Europe. Harper Collins, London, United Kingdom.

PALMER, R. [ED.]. 1988. Handbook of North American birds, Vols. 4 and 5. Yale University Press, New Haven, CT U.S.A.

PORTER, R.F., I. WILLIS, S. CHRISTENSEN, AND B.P. NIELSEN. 1981. Flight identification of European raptors, 3rd Ed. T. & A.D. Poyser Ltd., London, United Kingdom.

PYLE, P. 1997. Flight-feather molt patterns and age in North American owls. *Monogr. Avian Biol.* 2:1–32.

———. 2005. First-cycle molts in North American Falconiformes. *J. Raptor Res.* 39:378–385.

RASMUSSEN, P.C. AND J.C. ALDERTON. 2005. Birds of South Asia, Vol. 1: field guide. Lynx Edicions, Barcelona, Spain.

———, W.S. CLARK, S.J. PARRY, AND N.J. SCHMITT. 2001. Field identification of "Long-billed Vultures" (Indian and Slender-billed Vultures). *Bull. Orient. Bird Club* 34:24–29.

SHIRIHAI, H. AND P. DOHERTY. 1990. Steppe Buzzard plumages. *Birding World* 3:10–14.

SIBLEY, D. 2000. The Sibley guide to birds. Alfred A. Knopf, New York, NY U.S.A.

STEVENSON, T. AND J. FANSHAWE. 2002. A field guide to the birds of East Africa: Kenya, Tanzania, Uganda, Rwanda, Burundi. T. & A.D. Poyser Ltd., London, United Kingdom.

WATSON, R.T. 1987. Flight identification of the Bateleur age classes: a conservation incentive. *Bokmakierie* 39:37–39.

WHEELER, B.K. 2003a. Raptors of eastern North America. Princeton University Press, Princeton, NJ U.S.A.

———. 2003b. Raptors of western North America. Princeton University Press, Princeton, NJ U.S.A.

——— AND W.S. CLARK. 1995. A photographic guide to North American raptors. Academic Press, London, United Kingdom.

ZIMMERMAN, D.A., D.A. TURNER, AND D.J. PEARSON. 1996. Birds of Kenya and northern Tanzania. Christopher Helm, London, United Kingdom.