Commentary: A Recommendation for Standardized Age-Class Plumage Terminology for Raptors

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SHORT COMMUNICATIONS

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COMMENTARY: A RECOMMENDATION FOR STANDARDIZED AGE-CLASS PLUMAGE TERMINOLOGY FOR RAPTORS

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We recommend that standard age-class terminology be used in publications that involve raptor plumages. We propose using standardized terminology developed by Humphrey and Parkes (1959) and refined by Howell et al. (2003) for all raptors, and we propose age-coding terms recommended by Wolfe et al. (2010) and Johnson et al. (2011), as described herein.

The age terms "subadult" (or "sub-adult") and "immature" are used frequently in raptor articles, raptor books, and raptor field guides, and often in the raptor sections of bird field guides. However, the uses and definitions of these terms have not been consistent among these publications. "Subadult" has been used to refer to birds in at least four different age/plumage classes: (1) the first adult plumage when juvenile feathers are present (e.g., Clark and Wheeler 2001); (2) the annual plumage preceding adult plumage (e.g., Clark 1999); (3) all plumages between juvenile and adult (e.g., Liguori 2011, Wheeler 2003); and (4) all non-adult plumages (e.g., Newton 1979). The term "immature" has been applied to raptors in at least two ways: (1) for all non-adult plumages (e.g., Wheeler 2003), and (2) for any plumage between juvenile and adult (e.g., Friedmann 1950; see also Clark 1999). However, the second definition has been used much less frequently. "Immature" means literally "not adult."

Most books and articles on ageing raptors for banding or ringing use calendar-based ageing terms (e.g., Baker 1993, Bloom and Clark 2001, and Pyle 2008 in part). Under such terminology, age classes advance on 1 January each year, despite no concurrent change in age-determination criteria. Such terminology is required for banding in North America (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1991), and similar calendar-based age coding is used in Europe and elsewhere. But such age-class terminology becomes much more confusing in equatorial regions or in the southern hemisphere, where hatching and fledging can span 1 January in a given species.

Additional sets of age terms that apply to raptors are available for use in lieu of "subadult" and "immature" and instead of calendar-based systems. All such sets have clearly and unambiguously defined terms that can be used for the various definitions above. We propose that the Humphrey and Parkes (1959) molt and plumage terminology, as modified by Howell et al. (2003; the "H-P-H" terminology) be used to indicate age classes in raptors rather than vague and/or calendar-based terms. We further propose that for instances when the age of the raptor cannot be determined, that the term "pre-definitive" be used for all non-adult plumages.

H-P-H Terminology Applied to Raptors. H-P-H terminology takes a "cycle-based" approach, in which a molt cycle or plumage cycle is defined as the period between the beginning of one prebasic molt to the beginning of the next prebasic molt (usually, but not always, a year). The growth of first pennaceous feathers in the nest is considered the first prebasic molt, and the period between this and the second prebasic molt (at about a year of age) is considered the first molt cycle, followed by the second molt cycle, and so on.

Older raptors, including most breeding adults, undergo a single prebasic molt per cycle (typically a year), unlike some bird species that have inserted prealternate molts and two or more plumages per adult cycle (e.g., one plumage during the breeding season and another plumage outside the breeding season, such as in the American Goldfinch [*Spinus tristis*]). In the first molt cycle, some raptors, such as New World vultures and perhaps some larger eagles and falcons, appear to lack an inserted molt in all cycles, resulting in the Simple Basic Strategy (SBS) as defined by Howell et al. (2003). However, most raptor species appear to have a limited or partial inserted molt during their first molt cycle (Pyle 2005a), as is found in most birds, and now referred to as the preformative molt. Most raptors, therefore, follow the Complex Basic Strategy

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Table 1. Comparison of cycle-based age-classification system codes recommended for North American raptors and equivalents using the calendar-based age-classification system, for the first, second, and definitive molt cycles. Calendar-based age codes are currently recognized by the U.S. Bird Banding Laboratory (BBL) for north-temperate breeding birds. The BBL (http://www.pwrc.usgs.gov/BBL/MANUAL/index.cfm) is currently adopting WRP classification codes as well. Note that some species have identifiable fourth-cycle (4CB) and fifth-cycle (5CB) basic plumages as well. Table adapted from that of Pyle et al. (2015).

MOLT-BASED AGE-CLASSIFICATION SYSTEM		CALENDAR-BASED AGE-CLASSIFICATION SYSTEM	
FCJ	1st molt cycle, juvenile plumage	**HY**	Hatching year
FPF	1st molt cycle, undergoing PF molt	**HY**	Hatching year
FCF	1st molt cycle, formative plumage	**HY/SY**	Hatching year/2nd year
SPB	2nd molt cycle, undergoing 2nd PB molt	**SY**	2nd year
SCB	2nd molt cycle, basic plumage	**SY/TY**	2nd year/3rd year
TPB	3rd molt cycle, undergoing 3rd PB molt	**TY**	3rd year
DPB	Definitive molt cycle, undergoing definitive prebasic molt	**AHY/ASY**	After hatch year/after 2nd year
DCB	Definitive molt cycle, basic plumage	**AHY/ASY**	After hatch year/after 2nd year

(CBS) according to Howell et al. (2003). Note that the term CBS refers to the species, but not all individuals of the species undergo a preformative molt; in other words, the molt can vary from absent to limited within a species (Pyle 2005a).

In H-P-H terms, raptors during the first molt cycle can be in "Juvenile Plumage" throughout the first cycle in SBS species and some individuals of CBS species, or "Juvenile Plumage" followed by "Formative Plumage" in most individuals of CBS species. In all raptor species this is followed by "Basic II" or "Second Basic" plumage during the second molt cycle, "Basic III" or "Third Basic" plumage during the third molt cycle, and so on, until "Definitive Basic" plumage is attained, the plumage that remains essentially static from year to year and is found in most breeding adults. This can occur variously among raptor species during the second cycle beginning at 1 yr old (e.g., kites, some other smaller Accipitrids, and falcons) or during the fifth or later cycle beginning at five or later years of age (e.g., in Bald Eagle [*Haliaeetus leucocephalus*], and California Condor [*Gymnogyps californianus*]); it is not always attained during the same cycle in all individuals (Pyle 2008). Thus, knowledge of specific maturation rates are needed to understand the minimum age for which Definitive Plumage can be applied, and it is not a term that can be assumed to represent homology between species or paralogy within species (Howell and Pyle 2014).

For age-coding in the field or in databases, a system based on H-P-H terminology has been derived by Wolfe et al. 2010), the "WRP system" as modified by Johnson et al. (2011). See Pyle et al. (2015) for a thorough treatment of its use. For diurnal raptors, applicable plumage and molt codes are: FCJ (First Cycle, Juvenile Plumage); FPF (First Cycle, undergoing the Preformative Molt); FCF (First Cycle, Formative Plumage); SPB (Second Cycle, undergoing the Second Prebasic Molt); SCB, TCB, 4CB, 5CB, etc. (Second, Third, Fourth, Fifth, etc. Basic Plumages); TPB, 4PB 5PB, 6PB, etc. (undergoing the Third, Fourth, Fifth, Sixth, etc. Prebasic Molts); DPB (undergoing the Definitive Prebasic Molt); and DCB (Definitive Basic Plumage). Various codes for "unknown" plumages are also available (see Johnson et al. 2011, Pyle et al. 2015). Although these codes were derived primarily for tropical species in which calendar-based age-coding systems are not useable, the codes can equally be applied to temperate North American species and this coding system will be introduced as an option by the Bird Banding Laboratory (BBL; J. Lutmerding pers. comm.; Table 1). The WRP codes can be used to compare molts and plumages of raptors with the Simple Basic Strategy to those with the Complex Basic Strategy, and to define age-groups as based on the molting strategies of each species (Fig. 1).

Summary of Molts, Plumages, and Proposed Age Designations and Codes. *Juvenile plumage (FCJ).* This is the plumage acquired in the nest after the downy stages and is synonymous with "First Basic Plumage." It is the first plumage of a raptor and in some species can be worn for almost a year, throughout the first cycle, until commencement of the Second Prebasic Molt (SBS species and some individuals of CBS species). All North American raptors have distinct juvenile plumages, although those of male and female American Kestrels (*Falco sparverius*) differ only slightly from later plumages of each sex.

Formative plumage (FCF). This plumage results from a limited-to-incomplete Preformative Molt, inserted within the first cycle of raptors showing the CBS molt strategy. Birds undergoing the Preformative Molt can be coded FPF. This plumage occurs in some to many individuals of most to all North American raptors, between juvenile and second-basic plumages (Pyle 2005a), but has not been observed in New World vultures. In most species, formative plumage resembles juvenile plumage, but with a few newer feathers in the upperparts and underparts, which may resemble definitive plumage or be intermediate between juvenile and definitive plumage. Three North American species, American Kestrel, Mississippi Kite (*Ictinia mississippiensis*),

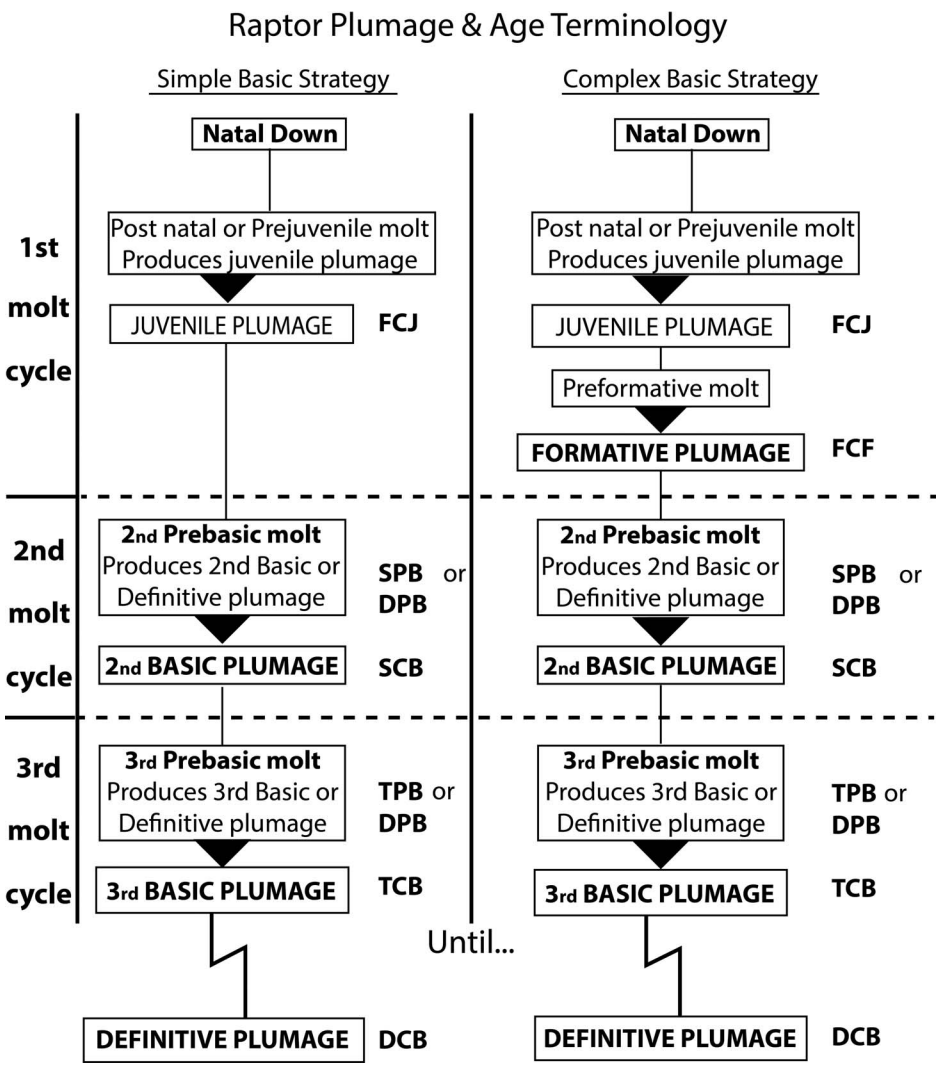

Figure 1. Comparison of molt cycles and plumages of Simple Basic Strategy with Complex Basic Strategy using WRP codes.

and White-tailed Kite (*Elanus leucurus*), have more extensive preformative molts that include most or all body feathers and, in the White-tailed Kite, can include flight feathers as well (Pyle 2005a, 2008). In these species, formative body plumage approaches or resembles definitive plumage.

Basic II or second basic plumage (SCB). This is the second full plumage of a raptor, following the second prebasic molt, which is complete or nearly complete in North American species, usually at 10 to 15 mo of age. Individuals undergoing the second prebasic molt can be coded SPB. In some North American species, including most falcons, most kites, and Red-shouldered Hawk (*Buteo lineatus*), second basic plumage corresponds to definitive basic plumage and most or all birds after the second prebasic molt are coded DPB as opposed to SPB. Other species, including eagles, condors, caracaras, and larger Buteonines, can have distinctive second-basic body plumages. In still other species, including Accipiters, harriers, and most Buteos, body plumage may or may not resemble definitive-basic body plumage, but second-basic plumage can be identified by retained juvenile outer primaries and/or secondaries in some or all individuals (Clark 2001, Bloom and Clark 2001, Clark and Bloom 2005, Pyle 2005b, 2006, 2008).

Basic III or third basic plumage (TCB). This is the third full plumage of a raptor, acquired by a complete or incomplete third prebasic molt at about 2 yr of age; birds actively undergoing this molt can be coded TPB. Third-basic body plumage resembles definitive basic plumage in most North American species (for which TCB cannot be coded) but differ markedly in Bald Eagle and California Condor, and subtly in a few other larger species. In the eagles, condor, Osprey (*Pandion haliaetus*), White-tailed Hawk (*Geranoaetus albicaudatus*), and Rough-legged Hawk (*Buteo lagopus*), third-basic plumage in some or all individuals can be identified by retained juvenile outer primaries or medial secondaries along with two generations of basic feathers in *staffelmauser* (stepwise) patterns, as well as pre-definitive body plumages in some species (Bloom and Clark 2001, Clark 2004, Clark and Bloom 2005, Pyle 2005a, 2006, 2008).

Basic IV, V, and VI, or fourth, fifth, and sixth basic plumages (4CB, 5CB, and 6CB). These plumages follow the fourth, fifth, and sixth prebasic molts, which are incomplete to complete and occur at about 4, 5, and 6 yr old, respectively. Birds undergoing these molts can be coded 4PB, 5PB, and 6PB. Among North American raptors, only Bald Eagle and California Condor have distinct fourth-basic plumages, some individuals of these species have recognizable fifth-basic plumages, and occasional individuals may show recognizable sixth-basic plumages. In all other North American species these plumages are not distinguishable from Definitive Basic Plumage.

Definitive basic plumage (DCB). This is the final mature plumage state that follows the definitive prebasic molt, and is often referred to as "adult" plumage. Definitive plumage is typically worn by breeding adults, however, and is assumed with little or no appearance change year after year once it is attained. Birds undergoing this molt can be coded DPB. In North American raptors, definitive plumage can be attained anywhere between the first and the seventh cycles (see above); although in most species it is attained during the second or third cycle. Flight feathers reach definitive molting patterns anywhere between the second and seventh cycle. Note, however, that definitive molts and plumages can vary substantially between and among species and individuals of a species, and that, in contrast to other H-P-H terms, it should not be used to determine evolutionary plumage homologies (Howell and Pyle 2014).

We have provided clear and unambiguous age terms for all raptor age classes. We recommend that the vague and inconsistently used term "subadult" be avoided in raptor publications. If the age of a raptor is precisely known, the WRP codes can be used as nouns, as in "a DCB." But if the age is not known, we recommend using "pre-definitive" (or "immature") when the raptor is in any plumage preceding definitive plumage. The terms "adult" and "immature" thus beome synonyms of "definitive" and "pre-definitive," respectively.

COMENTARIO: RECOMENDACIÓN PARA EL USO DE UNA TERMINOLOGÍA ESTANDARIZADA DE PLUMAJES DE CLASES DE EDAD PARA RAPACES

RESUMEN.—Los términos "subadulto" e "inmaduro" han sido aplicados en forma vaga e inconsistente en la literatura sobre rapaces. Además, los sistemas de registro de envejecimiento basados en el calendario generan cambios en los códigos a pesar de que no ocurren cambios en la apariencia exterior u otros criterios utilizados para determinar la edad, y no pueden ser utilizados en las regiones ecuatoriales donde las aves pueden reproducirse desde el uno de enero. Para clarificar y añadir consistencia a la terminología de muda y de plumaje en rapaces, presentamos un grupo estandarizado de términos de clases de edad y de códigos para reemplazar los términos que no han sido definidos universalmente. Proponemos una terminología basada en un ciclo y una codificación que aplique una nomenclatura precisa sobre la muda y el plumaje para aves rapaces de las que se conoce la edad, y presentamos una cronología de mudas y plumajes, así como sus códigos, para su uso en rapaces de América del Norte. En los casos en los que la edad real no pueda ser determinada, proponemos el uso del término "pre-definitivo" (o "inmaduro") para rapaces que no son ni adultos ni juveniles.
[Traducción del equipo editorial]

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