

## BCPOS Volunteer Naturalist Advanced Training Raptors of Boulder County/Glossary of Relevant Terms

**Accipiter:** the **nominate** and largest (52 species worldwide/3 in North America) genus in the family **Accipitridae** (Kites, Eagles and Hawks); referred to as “true hawks”, **Accipiters** established the baseline for inclusion in the “*Family*” based on morphology (form and structure), however, recent changes to classification protocol centered on DNA studies and wing molt patterns have led to major taxonomic reclassification of avian species, including raptorial birds or “birds of prey”; see **American Ornithologists’ Union**; all three (3) North American species are year round residents of Boulder County; Sharp-shinned Hawk (SSHA), Cooper’s Hawk (COHA), Northern Goshawk (NOGO).

**Adaptive radiation:** in evolutionary biology, a process by which organisms diversify rapidly from an ancestral species into a multitude of new forms, particularly when a change in the environment makes new resources available or opens new environmental niches. Starting with a recent single ancestor, this process results in speciation and phenotypic adaptation (variation resulting from genetic and environmental influences) of an array of species exhibiting different morphological and physiological traits. Darwin’s Finches (recently determined to have evolved from Tanagers through DNA research) are a well know example of **adaptive radiation**. The evolution of flight in birds opened new avenues for evolution to explore, initiating an **adaptive radiation** on a grand scale; example: asymmetrical hearing/triangulation and silent feathers in owls; sharply hooked beaks and talons and their powerful associated musculature in most raptors; placental gestation and bipedal locomotion in hominids are all examples of **adaptive radiation**.

**Albinism:** color variation caused by an absence or reduction of pigments in feathers, skin or irises, including four (4) types; **total albinism**, in which all pigments are absent from feathers, skin and irises (rare); **incomplete albinism**, in which pigment is absent from one or more of the feathers, skin or irises, but not all three; **imperfect albinism**, in which all pigments are reduced or at least one pigment is absent; **partial albinism**, the most common form in birds, in which pigments are reduced or absent from parts of the feathers, skin and irises, Randall T. Cox, *Birders Dictionary*, 1996; Red-tailed Hawk (RTHA) presents in albino/leucistic form more than any other North American diurnal raptor; see **leucism**

**Allen’s Rule:** a rule of adaptation to environment which says that bills, tails and other extensions of the body tend to be longer in warmer climates (maximizes exposed surface area/heat loss) and shorter in cooler climates (minimizes exposed surface area/heat loss); this adaptation is demonstrated in Rough-legged Hawk (RLHA) in the form of a small beak and toes/talons; Joel Asaph Allen (1838-1921), Harvard educated, a student of Louis Agassiz; first president of the **American Ornithologists’ Union (AOU)** and Curator of the American Museum of Natural History Department of Ornithology; see **Bergmann’s Rule, Gloger’s Rule**.

**Alpha Codes:** four (4) and six (6) letter codes representing English and scientific names respectively have been devised by the Bird Banding Lab (BBL) and the Institute for Bird Populations (IBP); the IBP annually updates the lists following taxonomic/common name changes adopted by the **American Ornithologist Union (AOU)**; initially the codes were used only by banders, but are now in more general use; an asterisk (\*) following a code denotes disagreement between the agencies; Harlan's Hawk (HALH\*).

**American Ornithologists' Union (AOU):** founded in 1883, one of the oldest, most diverse and largest ornithological societies in the New World; The *AOU Check List of North American Birds* is the accepted authority for English bird names and scientific nomenclature for most, if not all, scientific literature and field guides relating to North and Central American birds; the AOU's Committee on Classification and Nomenclature of North and Middle American Birds reviews and determines all taxonomic changes, English name changes, acceptance of distributional records and other items related to its charge; when documenting **species** distribution, the committee generally defers to state committees and to the American Birding Association (ABA) for acceptance of records; the last edition of the **AOU Check List** to include **subspecies** was published in 1957 (5<sup>th</sup> Edition), though the committee continues to endorse the biological reality and practical utility of **subspecies** as a taxonomic rank. **Note:** Due to a change in how taxonomic classification is determined, from the centuries long use of shared morphology (form and structure) to advanced DNA studies, **major** reclassification of avian species has occurred in the last several years, particularly regarding New World Vultures and falcons. For the most recent reclassifications, consult the *AOU Check List of North American Birds*, 7<sup>th</sup> edition of the 57<sup>th</sup> supplement, July 2016 (AOU 2016).

**Anisodactyl:** having three toes (2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup>) forward and one, the hallux (1<sup>st</sup>), often called the "killing toe", facing to the rear; the most common foot configuration in bird species; see **tendon locking mechanism, zygodactyl**.

**Aspect ratio:** the proportion of wing length to width; short, broad wings have a low **aspect ratio** and may require more rapid wingbeats to achieve sufficient lift than long, narrow wings; Swainson's Hawk (SWHA), a long distance (12,000 miles round trip) **complete transequatorial migrant**, has evolved long, narrow wings, atypical of most buteonine hawks, to support its migration ecology.

**Asynchronous hatching:** determined by the onset of incubation with the laying of the first egg in the clutch; eggs hatch in the order and interval in which they were laid; larger, more aggressive young (the first to hatch) can out-compete smaller siblings when prey is in short supply; a **brood reduction** strategy that assures survival of fewer/stronger young in times of low prey availability.

**Automatic apportionment:** a process by which food is distributed among nestlings such that the most aggressive nestlings (the first to hatch) are satisfied first, thence down to the least aggressive; a **brood reduction** strategy that assures survival of fewer/stronger young in times of low prey availability.

**Avivory, avivorous:** a form of carnivory; describes organisms that prey exclusively or primarily on birds; Sharp-shinned Hawk (SSHA), Cooper's Hawk (COHA), Northern Goshawk (NOGO), Prairie Falcon (PRFA), Peregrine Falcon (PEFA).

**Band:** a broad bar of color; a broad, transverse (crossing from side to side) mark with regular and nearly parallel edges; see **bar, streak**.

**Bar, barring:** a narrow, transverse (crossing from side to side) mark of color; see **band, streak**.

**Bergmann's Rule:** a rule of adaptation to environment that says body size tends to be larger in colder climates and smaller in warmer climates in birds and mammals. The ratio of body volume to body surface is higher in colder climates, thereby helping to conserve heat, whereas the converse is true in environments where cooling is needed; this rule applies only within species; Carl Bergmann (1814-1865), German biologist; see **Allen's Rule** and **Gloger's Rule**.

**Brood reduction:** reduction of the number of young in the nest by a variety of processes (**asynchronous hatching, automatic apportionment, cannibalism**) for the purpose of assuring the survival of fewer/stronger young in times of low prey availability.

**Cannibalism (fratricide, siblicide, Cainism):** killing of a nest mate by another (larger/more aggressive, typically the first to hatch) to eliminate competition for food, a **brood reduction** strategy; "**facultative**" in species where it occurs only during periods of low prey availability (kites, harriers, accipiters, buteos, sea eagles, booted eagles and several owl species); "**obligate**" in species where it occurs regardless of prey availability (no North American species is represented); Keith L. Bildstein, *Raptors: The Curious Nature of Diurnal Birds of Prey*, 2017.

**Color morph:** plumage variation within some raptor species (six *buteos* and one falcon) that is sometimes geographically designated and occasionally is a climatic adaptation (see **Gloger's Rule**); darker coloration of these species is the result of increased amounts of *phaeomelanin* and *melanin* (darker feather pigmentation) which results in *erythristic* (rufous morph) and *melanistic* (dark morph) birds, respectively. Many of these species also have an intermediate division between each major color morph. Also called "phase" (suggests transience) though "morph" is the more accepted scientific term. (Brian K. Wheeler, *Raptors of Western North America*, 2003)

**Diagnostic:** distinctly characteristic or exclusively applicable; pertaining to diagnoses.

**Dihedral:** the wing attitude of a flying bird in which the wing is held in various angles above the horizontal plane; reduces the potential of stalling during slow, gliding flight and demonstrated by Golden Eagle (GOEA), Northern Harrier (NOHA) and Turkey Vulture (TUVU).

**Dimorphic:** showing a distinct difference in color or size; often used in sexual variation (plumage/size/**RSD**) in raptors.

**Dispersal:** purposeful movement away from population centers that acts to separate members of populations; often undertaken by recently fledged/emancipated individuals, dispersal acts to increase population ranges and reduce population densities overall.

**Double endemic:** a migratory species that is native to and restricted to relatively small breeding and wintering areas that are geographically separated from each other; Swainson's Hawk (SWHA), Broad-winged Hawk (BWAH), both **complete transequatorial migrants** that breed in North America and winter in South America.

**Endemic, endemism:** defines organisms that originate in, evolve in and remain confined to a specific geographic region; Prairie Falcon (PRFA), Ferruginous Hawk (FEHA) and Bald Eagle (BAEA) are North American **endemic** species; see **double endemic**.

**Fledgling:** a young bird that has attained the ability of flight, but is still cared for by parents.

**Fossil record, raptors:** the **oldest** raptor fossil discovered to date is that of a burrowing owl predecessor unearthed near Tiffany, La Plata County, Colorado in 1916 and dating back to the Paleocene Era (60 MYA); the fossil is named *Ogygoptynx* and is part of a larger set of fossils called the *Tiffanian Fauna* relative to the *Tiffanian North American Stage* 60,200,000 to 56,800,000 years ago, part of the North American Land Mammal Ages (NALMA) chronology and coinciding with the mid to late period of the *Laramide Orogeny*, the uplift of the modern day Rocky Mountains; the **largest** raptor fossil is *Teratornis incredibilis*, a vulture-like raptor with a 17 foot wingspan; fossilized remains have been discovered in Nevada and California and date to the end of the Pleistocene Ice Ages about 10,000 years ago; extinction occurred primarily as a result of climate change and the loss of large mammal carcasses (mammoth, mastodon, giant ground sloth, etc.) upon which it fed; Keith L. Bildstein, *Raptors: The Curious Nature of Diurnal Birds of Prey*, 2017.

**Frequency-dependent selection:** the term given to an evolutionary process where the fitness of a phenotype (an organism whose characteristics are the result of genetic and environmental influence) depends on its frequency relative to other phenotypes in a given population; in **positive frequency-dependent selection** the fitness of a phenotype increases as it becomes more frequent; in **negative frequency-dependent selection** the fitness of a phenotype decreases as it becomes more common; usually the result of interactions between species (predation, parasitism or competition) or between genotypes (organisms whose characteristics are designated solely by genetics) within species (usually competitive or symbiotic) and has been frequently discussed with relation to anti-predator adaptations that can lead to polymorphic equilibria; a theorized cause of "**polymorphism**" in raptors (and other organisms); Dr. Dennis Paulson, *Polymorphism and Apostate Selection*, 1973; see **melanism**.

**Gape:** the fleshy "lip" surrounding the mouth and connecting the "mandibles".

**Gloger's Rule:** a rule of adaptation to environment that says coloration tends to be darker in cooler/humid climates and lighter in warmer/arid climates; demonstrated in Harlan's Hawk

which nests in far northern latitudes and presents in dark morph form 88% to 92% of the time, the converse of other Red-tailed Hawk (RTHA) subspecies; applies only within species; theorized by C. W. L. Gloger (1803-1863), German zoologist and ornithologist, *The Variation of Birds Under the Influence of Climate*, 1833; see **Allen's Rule** and **Bergmann's Rule**.

**Intergrade, intergradation:** cross-breeding of different subspecies within a single species; the resultant offspring are called **intergrades** which are capable of reproducing; generally intergrades are undetectable in the field; distinguished from **hybrid/hybridization**, crosses between species that typically produce infertile offspring (supports reproductive isolation/preserves the sanctity of species, rare).

**Intergrade zone:** areas where periphery sub-specific ranges meet and **intergradation** regularly occurs; "Western" race Red-tailed Hawk (RTHA), *Buteo jamaicensis calurus* intergrades with *B. j. borealis* and *B. j. kriderii* in the eastern part of its range with potential *kriderii/calurus* crosses occasionally detectable in the field (in Boulder County during fall/outbound and spring/inbound migration) due to atypically pale plumage; *B. j. harlani/calurus* **intergradation** regularly occurs where those ranges overlap in northern Canada and Alaska; most **intergrades** are undetectable in the field.

**Juvenile:** a young bird in first flight feathers that is fully grown and totally self-sufficient; juvenile plumage may be retained for only a few months on some (smaller) species, but generally for one year on most raptor species; some large raptors may retain portions of this first plumage for several years; Bald Eagle (BAEA), Golden Eagle (GOEA).

**Leucism:** in leucistic birds, affected plumage lacks melanin pigment due to the cells responsible for melanin production being absent. This results in white feathers unless the normal plumage color also compromises carotenoids (e.g. yellows), which remain unaffected by the condition. Although leucism is inherited, the extent and positioning of the white coloration can vary between adults and their young and can also skip generations if leucistic genes are recessive. The reduction of pigment in leucistic birds causes feathers to weaken and be more prone to wear. In some situations this can hinder flight which, in addition to leucistic birds being more conspicuous, can heighten risk of predation. There is also evidence leucistic birds might, on occasion, not be recognized or accepted by a potential mate. Leucism differs from albinism in that albinos have pink eyes while the iris pigmentation of leucistic birds remains dark, British Trust for Ornithology (BTO), *Abnormal Plumage Survey*, 2011; see **albinism, melanism**

**Melanism, melanisitic:** an excess of dark pigments (melanin) in feathers; contrast with **albinism**; exhibiting an excess of dark pigmentation, as in a dark morph; **adaptive melanism** is heritable/genetic and can lead to the creation of intermediate or dark morph buteonine hawks; in Boulder County, Red-tailed Hawk (RTHA), Swainson's Hawk (SWHA)/rare, Harlan's Hawk (HALH\*)/common, Ferruginous Hawk (FEHA)/rare; see **albinism, leucism, frequency-dependent selection**.

**Migration, migrant:** describing birds (or other organisms) that regularly traverse between separate nesting and wintering areas:

- **Complete migrant:** describes species in which 90% or more of the aggregate/regional population migrates, the least common form of migration; includes Osprey (OSPR), Swainson's Hawk (SWHA), Broad-winged Hawk (BWAH), Rough-legged Hawk (RLHA).
- **Partial migrant:** fewer than 90% of the aggregate/regional population migrates, the most common form of migration; includes Turkey Vulture (TUVU), Bald Eagle (BAEA), Northern Harrier (NOHA), Sharp-shinned Hawk (SSHA), Cooper's Hawk (COHA), Northern Goshawk (NOGO), Red-tailed Hawk (RTHA), Ferruginous Hawk (FEHA), Golden Eagle (GOEA), American Kestrel (AMKE), Merlin (MERL), Prairie Falcon (PRFA), Peregrine Falcon (PEFA).
- **Irruptive/local migrant:** movement occurs sporadically over shorter distances; birds that occupy the middle of a latitudinal gradient may exhibit a mixed pattern, some migrate and some are sedentary and may shift from year to year due to prey availability.
- **Altitudinal migrant:** describes birds that reproduce at higher elevations and retreat to lower elevations in winter; in Boulder County, Red-tailed Hawk (RTHA), Sharp-shinned Hawk (SSHA), Cooper's Hawk (COHA), Northern Goshawk (NOGO), Great Horned Owl (GHOW).
- **Differential migration:** age or sex-related differences in one or more aspects of migration behavior such as direction or speed of travel, distance traveled and timing of departure; Osprey (OSPR) mated pairs migrate independently of each other and winter in different areas with males typically moving further south than females; displaying strong nest site fidelity, the male precedes the female **inbound** (flight to the nesting area) and juvenile Osprey (OSPR) do not return to their natal area until two (2) years of age (in the third year of life), **delayed return migration** reduces risks associated with migration and competition for food with adults.
- **Elliptical/loop migration:** occurs when **outbound** (flight to the wintering area) and inbound migrations differ latitudinally with longitude; in the Northern Hemisphere, loop migration typically produces clockwise movements, with returning inbound migrants traveling west of where they had traveled south during outbound migration; often results from greater wind drift during the early stages of outbound and return migration; Broad-winged Hawk (BWAH) occurs in Boulder County in spring only on its more westerly inbound loop segment.
- **Transequatorial migrant:** describes birds that cross the equator during both inbound and outbound migration; rare among migratory raptors; Osprey (OSPR), Swainson's Hawk (SWHA) and Broad-winged Hawk (BWAH) are rare **complete transequatorial** migrants. Keith L. Bildstein, *Migrating Raptors of the World: Their Ecology and Conservation*, 2006.

**Monotypic:** species that do not have recognized subspecies; Ferruginous Hawk (FEHA), Swainson's Hawk (SWHA), Cooper's Hawk (COHA), Prairie Falcon (PRFA).

**Motion parallax:** visually, when an object closer to you tends to move at a faster speed than an object that is farther away; when an observer moves, the apparent relative motion of several stationary objects against a background gives hints about their relative distance when direction and velocity of movement provide absolute depth information; called “depth perception” in humans and “depth awareness” in all other organisms that can judge depth visually; head bobbing by some bird species is a form of **motion parallax**.

**Natural Selection:** the process whereby organisms better adapted to their environment tend to survive and reproduce more offspring; any characteristic of an individual that allows it to survive and produce more offspring will eventually appear in every individual of that species; Charles Darwin, *On the Origin of Species*, 1859.

**Nominate:** referring to a taxon (any taxonomic unit or category related to the science of biological classification) that is the nomenclatural basis for the name of the larger taxonomic group to which it belongs; e.g., the genus *Accipiter* in the family *Accipitridae*; Paul A. Johnsgard, *Hawks, Eagles and Falcons of North America*, 1990.

**Ocelli:** dark or light spots on the nape that appear as “fake” eyes, possibly to deter predators; commonly found in falcons and owls; American Kestrel (AMKE), Northern Pigmy Owl (NOPO).

**Patagia:** a fold of vascularized/elasticized skin on the leading edge of the inner wing of a bird that connects the shoulder, elbow and wrist; **patagium**/plural, **patagial**/adjective.

**Polymorphism, polymorphic:** referring to species that have multiple color morphs; Red-tailed Hawk (RTHA), Boulder County’s predominant subspecies *Buteo jamaicensis calurus* presents in more color morphs than any other North American buteonine hawk, on a continuum from light to dark (Wheeler, 2003); Ferruginous Hawk (FEHA), rare, 1% of the aggregate population is dark morph; Harlan’s Hawk (HALH\*), 88% to 92% are dark morph, exemplifies **Gloger’s Rule**; Swainson’s Hawk (SWHA), less than 1% of the Colorado Front Range population is dark morph which are more prevalent west of the Rocky Mountains (Wheeler, 2003).

**Polytypic:** referring to species that have recognized **AOU subspecies**; Red-tailed Hawk (RTHA), 14 recognized subspecies worldwide/6 found in North America (*Buteo jamaicensis calurus*, resident/year round and *B. j. harlani*, winter only in Boulder County); Rough-legged Hawk (RLHA), 3/1 in North America; *Buteo lagopus sanctijohannis*, winter only in Boulder County; Broad-winged Hawk (BWAH), 6/1 in North America, the **nominate** subspecies *Buteo platypterus platypterus*, a transient spring only migrant in Boulder County; Sharp-shinned Hawk (SSHA), 7/3 in North America, *Accipiter striatus velox* in Boulder County; Northern Goshawk (NOGO), 8/2 in North America; *Accipiter gentilis atricapillus* in Boulder County; American Kestrel (AMKE), 17/3 in North America, the **nominate** subspecies *Falco sparverius sparverius* in Boulder County; Peregrine Falcon (PEFA), 17/3 in North America, *Falco peregrinus anatum* in Boulder County; Merlin (MERL), 9/3 in North America, *Falco columbarius richardsonii* in small numbers, typically winter only in Boulder County; Bald Eagle (BAEA), 2/both in North America only, **endemic**, the **nominate** subspecies *Haliaeetus leucocephalus leucocephalus* in Boulder County; Golden Eagle

(GOEA), 2/1 in North America, *Aquila chrysaetos canadensis*; Osprey (OSPR), 4/1 in North America, *Pandion haliaetus carolinensis*; **American Ornithological Union (AOU)**, *Checklist of North American Birds*, 1957, 5<sup>th</sup> Edition.

**Race:** an alternate name for **subspecies**; the terms are interchangeable.

**Resident:** residing in the same area year-round; sedentary, not migratory.

**Reverse Sexual Dimorphism (RSD):** female size exceeds that of males; the reverse of other higher vertebrates; in the Class *Aves*, **RSD** occurs in birds that have adopted polyandry (more than one male mated to a single female) or reversal of the sex role (male incubates, broods, rears the young) as an adopted reproductive strategy (includes Neotropical tinamous, jacanas and phalaropes); a wide variety of mainly aerial hunters including piratical/predatory frigate birds, boobies and skuas (males smaller in weight than in linear measurements) and owls and many diurnal raptors; most extreme in a number of accipiters and a few falcons whose males are well under two-thirds the bulk of females; James Ferguson-Lee and David A. Christie, *Raptors of the World*, 2001; **Research/theories pertaining to RSD:** food specialization; most acute in species (accipiters and some falcons) that feed largely/exclusively on birds (**avivory, avivorous**) or fast moving mammals; dimorphism increases with the speed and agility of prey; smaller male hunts/provides food, hunts smaller, more readily available prey; larger female guards nest/young, capable of taking larger prey (Hill 1944, Ferguson-Lee 1950); female social dominance during the reproductive cycle; larger males perceived a threat to young/female (e.g. Cade 1982, Smith 1982); to maintain flight performance (wing loading and power:weight ratio) when female adds weight by taking on food reserves for egg production and incubation (Wheeler and Greenwood 1995); egg weight as a proportion of body weight, example: Sharp-shinned Hawk lays eggs equivalent to about 13% of body weight (displays highest degree of **RSD**), Golden Eagle lays eggs equivalent to 4% of body weight (displays lower degree of **RSD**) (Newton 1979); the “natural selection” of **RSD** is poorly understood and “cause and effect” has not been determined.

**Species:** a population of interbreeding individuals possessing common characteristics distinguishing it from other populations and generally reproductively isolated from other populations.

**Subadult:** a general term for any plumage and/or age that is older than juvenile, but not yet adult; for species that have more than one subadult age and/or plumage (eagles), additional designations are given a numerical rating; example: a one year old bird in its second year of life with Subadult I or Basic I plumage traits (Johnsgard, 1990/Wheeler, 2003).

**Subspecies:** taxonomic classification immediately below species; a subspecies is morphologically, physiologically or behaviorally distinct and geographically separate (in terms of habitat or range or, more narrowly, breeding habitat or range) from other members of the species, but capable of interbreeding with other subspecies (and producing fertile offspring,



**intergrades**) when they do occur in the same area; subspecies represent unique adaptations to regional environments; also called “**race**”; see **polytypic**.

**Streak, streaking:** a narrow, longitudinal (lengthwise) color mark or stripe.

**Supraorbital ridge:** the bony projection above the eyes of most raptors that shields and shades the eye and gives raptors their “fierce” look.

**Tendon locking mechanism (TLM):** most perching birds possess automatic locking mechanisms that enable elements of the tendons in the toes to intermesh and physically lock the toes in place for long periods of time at low energy cost; the **TLM** in raptors differ in two important ways; the **TLM** in raptors produces a “vise grip” within the toes themselves rather than from farther up the leg as in most birds; raptors can grip their prey with toes/talons and simultaneously move their legs which other birds cannot do; the **TLM** functions in a ratchet-like manner as small, rigid, well-defined projections called tubercles on the ventral surfaces of each flexor tendon lock on transversely running folds on the surrounding tendon sheath, allowing the bird to clutch prey without continuous musculature effort; the tubercles of owls, hawks and eagles are rectangular with longer sides running parallel to the surrounding folds, creating a surer, firmer grip (other species have rounded tubercles); size varies among raptor species (large prey/large talons require larger tubercles); the hallux (rear facing toe, toe #1, “the killing toe”), has a substantially larger **TLM** than the other three toes; Keith L. Bildstein, *Raptors: The Curious Nature of Diurnal Birds of Prey*, 2017.

**Visual acuity in raptors:** defined as “keenness of perception”, “the ability of an eye to resolve detail” or, by Keith L. Bildstein in *Raptors: The Curious Nature of Diurnal Birds of Prey*, 2017, as “how well the raptorial eye resolves two finite points in a visual landscape”; Dr. Gordon L. Walls calculated visual acuity in raptors at 8 times that of humans in his study “*The Vertebrate Eye and Its Adaptive Radiation*”, 1942; more recently, Erlich, Dobkin and Wheye, *The Birder’s Handbook*, 1988, report visual acuity in raptors to be 2 to 3 times that of humans; when addressing visual acuity in raptors, **do not conflate acuity with telescoping**. **Note:** due to slight stretching of the eye in owls resulting from large eye size and restricted cranial capacity related to auditory function, owls are believed to have telescopic vision on the order of 2X to 3X.

**Vermiculate, vermiculation:** marked with irregular, fine lines like the tracks of worms or resembling a herring-bone pattern; a pattern typically found on the breast/belly of adult Sharp-shinned Hawk (SSHA), Cooper’s Hawk (COHA) and Northern Goshawk (NOGO); also common on adult Western Race Red-tailed Hawk (RTHA), Boulder County’s predominant subspecies.

**Wing slotting:** a flight adaptation whereby large birds splay the outer primaries (“fingers”) on both the vertical and horizontal plane thereby creating separate aerodynamic surfaces to acquire added lift and maneuverability and reduce wing-tip drag at low speeds; each primary serves as an individual **high-aspect-ratio** wing, reducing wingtip turbulence and lowering the stalling speed of the wing so the bird can remain aloft at a slower speed; Pennycuick; 1982, Rasper, 1950.

**Zygodactyl:** “yoke-toed” with two (2) toes forward and two (2) toes back; describing feet with the first and fourth toes pointing to the rear and the second and third toes pointing to the front; common in Osprey (OSPR), woodpeckers, owls and parrots.

Volunteer Naturalist Sue Cass: December/2019