



Arnold Schwarzenegger
Governor

GUIDE TO RAPTOR REMAINS

**A Photographic Guide for
Identifying the Remains of
Selected Species of California Raptors**



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California Energy Commission
Public Interest Energy Research Program

Prepared by:



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Cover photo: Red-tailed hawk found at transformer pole, by Joel Hurmence

Abstract

In order to address avian fatalities, many utilities are now checking their equipment for potential areas that may pose hazards for birds. Identifying species of fatalities is important to estimate the risk to eagles, to determine the most effective type of retrofit, and to understand which species are found in that particular habitat. When decomposed carcasses, bone pieces, feathers, or pellets are found under electrical structures, it can be difficult to identify the species. This guide provides a resource for the identification of partial remains of selected avian species.

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Skeletal and feather remains of great horned owl.

INTRODUCTION

Birds and Electrical Structures

Birds frequently come into contact with electrical structures, including power lines, poles, mounted equipment, and wind turbines. The primary hazards posed to birds are electrocution and collision. Electrocution can occur whenever a bird completes an electrical circuit by spanning energized contacts (conductors, jumpers, or connectors) or spanning energized and grounded contacts. Birds with large wingspans, including most birds of prey, are at greater risk of electrocution.

Bird electrocutions and collisions not only injure or kill birds, but they can also start fires and cause expensive power outages. A preliminary estimate for the California Energy Commission of the costs of sustained outages and restoration costs by Energy and Environmental Economics, Inc. amount to \$15 to \$25 million for California. In Monterey County, Pacific Gas & Electric Company (PG&E) estimates that at least 5 to 15 percent of power outages in recent years were caused by bird and wildlife contacts with power lines and other electric utility structures; a rate of about one per week. In 2001, PG&E crews found 49 electrocuted birds that caused power outages in Monterey County (Singer 2002).



Golden eagles perched on pole of power distribution line.

Laws Protecting Birds

Most bird species in the United States are protected by one or more laws. The Migratory Bird Treaty Act of 1918 (MBTA) protects the vast majority of birds with the exception of a few species such as the introduced house sparrow, European starling, and rock pigeon (formerly rock dove) (see 50 CFR § 10.13 for a full list of species). The MBTA states that, unless permitted by regulation, it is unlawful to pursue, hunt, "take," capture, kill, possess, sell, barter, purchase, ship, export, or import any migratory birds, or any part, nests, eggs, or products thereof. Electrical utilities violate the provisions of the MBTA when their structures and lines cause bird electrocutions and collisions. Penalties include fines up to \$15,000 and up to 6 months imprisonment.

Introduction

The Bald and Golden Eagle Protection Act (EPA) provides additional protection specifically for eagles. The EPA was signed into law in 1940 to afford protection to bald eagles. It was amended in 1962 to afford protection to golden eagles, based on the similarity of appearance of golden eagles to immature bald eagles. The EPA states that no person shall "take," possess, sell, purchase, barter, offer for sale, transport, export, or import any bald or golden eagle alive or dead, or any part, nests or eggs, thereof without a valid permit to do so. The EPA increases protection beyond the MBTA by defining "take" to include "molest or disturb", and providing stiffer penalties including fines up to \$200,000 and up to 1 year imprisonment.

Additional protection is afforded to threatened and endangered bird species under the federal Endangered Species Act of 1973 (ESA) (50 CFR 17). This law affords protection to fish, wildlife, and plants listed as federally endangered or threatened. The ESA makes it unlawful to import, export, "take," transport, sell, purchase, or receive in interstate or foreign commerce any species listed as endangered or threatened. "Take" under the ESA means an act that kills, injures, or harms a listed species. The ESA also increases protection to habitat and prohibits the harassment of threatened and endangered species. Penalties include fines up to \$200,000 and up to 1 year imprisonment.

Enforcement Actions

The U.S. Fish and Wildlife Service (USFWS) has begun to increase enforcement of the MBTA, EPA, and ESA. In 1994, the USFWS cited Pacific Gas & Electric for not preventing deaths of protected Swainson's hawks in the Southern San Joaquin Valley (Singer 2002). In 1999, with assistance from the USFWS, the U.S. Justice Department prosecuted the Moon Lake Electric Association for bird deaths, mostly golden eagles, on its power lines in western Colorado and eastern Utah (United States v. Moon Lake Electric Association, 45 F. Supp. 2d 1070, D. Colo. 1999). This was the government's first criminal prosecution of a utility for violation of the MBTA and the EPA. The company pleaded guilty, received a fine of \$100,000 (which included a \$50,000 contribution for raptor conservation) and agreed to retrofit its power poles with bird-friendly equipment. The USFWS has stated that it prefers to work with utilities as they take steps to make lines safer for birds, but will continue to refer cases for prosecution when it becomes necessary.



Great horned owl carcass on three-phase recloser.

Monitoring

In order to address avian fatalities, many utilities are now checking their equipment for potential areas that may pose hazards for birds. A common method of monitoring is to look under power lines for dead birds. Identifying species for these fatalities is important for several reasons. First, since eagles are afforded special protection under the EPA, it is of interest to know if a bird fatality is an eagle. Secondly, it is important to identify the species of each fatality in order to choose the most effective type of retrofit. Some retrofitting methods are effective for medium-sized raptors, but not sufficient for eagles. Finally, it is useful to understand which species are found in a given area in order to help identify other structures in similar habitats that can pose risk to those species.

When decomposed carcasses, bone pieces, feathers, or pellets (castings) are found under electrical structures, it can be difficult to identify the species. This guide provides a resource for the identification of partial remains of selected avian species.

How to Use This Guide



Two immature golden eagle fatalities found in western Colorado. The first fatality (bones in foreground) is in a much more advanced state of decomposition.

HOW TO USE THIS GUIDE

Investigators should consider a number of factors when animal remains are discovered. Such factors include the kind of animal(s) present, extent of decomposition of the remains, number of individuals and species present, and relocation/modification of the remains resulting from scavenging and other activities. After making these initial determinations, this guide can be used to assign bird remains to species or group.

This guide focuses on the partial and skeletal remains of raptors and other birds commonly encountered as fatalities near power structures. For mammalian remains, investigators may refer to other guides, including Gilbert (1990), Roest (1991), Jones and Manning (1992), and Kaufman, Bowers, and Bowers (2004). To identify complete bird carcasses, a standard field guide to birds is useful, such as Wheeler (2003) and Sibley (2000). It is worth mentioning that eagle carcasses are sometimes found with the tail feathers missing. Because of their

value, the tail feathers of immature golden eagle carcasses are sometimes taken by human scavengers. This practice is illegal and it also makes identification of eagle species more difficult.

The site should be inspected carefully for signs of bird remains. It is likely that scavengers have visited the carcass and scattered or removed certain parts. One may notice a partial carcass, a cluster of feathers, or a few bones. Older remains are often partially buried. At first glance, the quills of decomposed feathers can resemble dry plant stalks. One visible part can indicate that more remains are just below the surface or nearby.

If a dangerous pole or structure is a preferred perch, remains from multiple fatalities can accumulate. If birds use the perch while eating, the remains of prey animals also can accumulate. Take note of various remains that appear to be in different stages of decomposition. If bones are present, determine which are avian using the hints given on pages 15-18. If a skull is recovered, use the skull chart on page 20 to determine possible group(s). If numerous bones are present, take note of the number of each kind, keeping in mind that some bones are paired (left and right) in the avian skeleton (refer to appendices). Your goal is to determine how many individuals and which species are present.

For skeletal remains, the measurement charts in this guide can be used to suggest some possible species. These charts include most birds of



The bone scatter on the left has been arranged for inspection on the right. The third humerus is evidence that more than one individual is present. Measurements of the other bones considered together are consistent only with great horned owl. The length of the small humerus is compatible with northern goshawk, red-tailed hawk, Swainson's hawk, barn owl, and common raven (Harris's hawk and barred owl are also compatible, but are not likely in the Colorado location).

How to Use This Guide

prey and other species likely to be encountered near power structures, but do not include all possible species. For skulls and feathers, the subsequent section provides an overview of the groups covered in this guide, followed by descriptions for each species. Descriptions include skull photographs, narrative description and measurements, as well as feather photographs and lengths if available. Referring to natural history information, such as range and typical habitat, also can help to narrow down the possibilities. It is not always possible to determine the species from a given set of remains, but careful examination can usually identify the group or a few possible species.

Precautions

Investigators should be aware that laws protect the remains of most birds. The MBTA and EPA (described in the introduction) not only prohibit the killing of the affected species, but also prohibit any person from taking possession of a dead bird, any bird part, nests, or eggs without the appropriate permit. Before beginning investigations, therefore, it is important to obtain and comply with the proper state and federal permits.

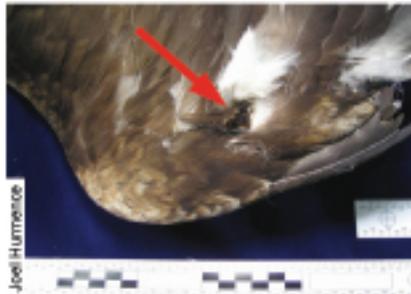
Investigators also must be aware that there are many diseases that can be transmitted by contact with wildlife and should wear gloves or use an inverted plastic bag to handle wildlife remains.



Electrocuted golden eagles showing singed primary feathers and exit wounds on toes.



Toes and lower portion of golden eagle foot detached by electrocution.



Electrocuted golden eagle with burn marks visible on the inside right wing.



Electrocuted red-tailed hawk still clutching its prey. Note burn mark on snake.

CAUSE OF DEATH

Electrocution

Electrocuted birds often show burn marks or singed feathers, as illustrated in the accompanying photos. Toes also frequently show burns or exit wounds or may be clenched tightly. However, electrocution does not always leave visible signs on the carcass, and skeletal remains rarely offer clues. In evaluating the cause of death, remember that a bird may be carrying prey, which increases the likelihood of spanning energized conductors/hardware and thereby completing an electrical circuit.

Collision

Flying birds sometimes collide with structures such as power lines and wind turbines. Collisions may occur anywhere along an overhead line,

Cause of Death

not necessarily near a support or pole. These collisions can cause one or more broken bones, particularly the furcula (wish bone), coracoid, and bones of the wing. Such injuries can result in death.

Shooting

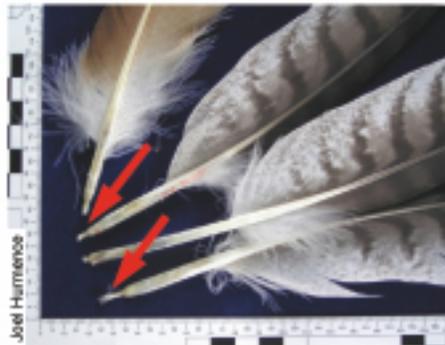
Raptors continue to be shot while perching on electrical distribution poles. When a perched bird is shot, the bullet sometimes cuts feathers as it passes through the body, a phenomena known as feather shearing, as illustrated in the adjacent photograph. Such fatalities can be judged to be the result of shooting, even if no bullet is recovered.



Feather shearing resulting from gunshot.

Other Causes

Fatalities can result from other causes, such as strike by automobile, entanglement, predation, and diseases. West Nile virus is a growing problem affecting corvids and raptors (Russell 2002). One symptom of this disease is constriction of the feather quills near the tip.



Red-tailed hawk feathers showing constriction of feather quills caused by West Nile virus.

SKELETON

Bones: Bird or Mammal?

Bones encountered while searching for electrocution fatalities at bases of power poles can include those of mammals, birds, reptiles, and fish. Bone accumulations can result from prey consumption, pellet egestion, and animals killed at the structure. The bones of small mammals (rabbits, prairie dogs and other small rodents) are most likely to be confused with those of raptors.

The bones of birds and mammals have the same general composition: a mixture of collagen fibers and crystalline minerals (mostly calcium phosphate). Both birds and mammals have some bones that are solid and some that are filled with marrow. There are differences, however. It is commonly stated that bird bones are hollow and very lightweight. These characteristics, although generally true, can be misleading when applied in the field, for the following reasons:

- The dried long bones of both mammals and birds are hollow. In live mammals, long bones contain blood vessels and marrow. In live birds, some long bones contain marrow and some are pneumatized (air-filled). The bones of young birds contain more marrow than bones of adults. Many bones of the avian skeleton are pneumatized by branches of the respiratory system air sacs, which invade the interior of bones and replace marrow. Pneumatized bones vary among different bird families, but usually include the femur, humerus, furcula, coracoid, sternum, vertebrae, and pelvis. This low bone density is advantageous for flight and buoyancy in water.
- Not all bird bones are lighter than the bones of equivalent sized mammals. While some bones are much lighter than their mammalian counterparts, others, especially the leg bones, humerus, and sternum, are heavier (Prang, Anderson, and Rahn 1979, as cited by Proctor and Lynch 1993:118).
- Decomposing bones in soil sometimes develop cracks and become filled with sediment, which makes them seem heavier than they actually are.

Skeleton

To identify bones as avian, hollowness and apparent weight should be used along with several other characteristics:

- Most bird bones have much less cortical bone than mammal bones of the same size. Specifically, the cylindrical walls of long bones in birds are thinner, relative to mammals. Because of this thinner cortex, bones have an internal lattice of struts (trabeculae) that acts to strengthen the bone.
- The trabecular bone (spongy interior bone) is denser in the ends of long bones, and denser in the lower limbs than the upper limbs, but is generally less dense in birds than in mammals. (There is additional trabecular bone deposited in the bones of female birds during the egg-laying cycle.)
- Bird bones have different form than mammal bones. For example, many bird bones seem rather small in diameter, for their length, when compared to mammal bones.
- The avian skeleton contains a number of distinctive bones. Many bones typical of vertebrates have been eliminated or fused in birds to reduce weight and increase rigidity. Recognition of these distinctive bones is useful in identifying partial avian skeletons.



Left: Broken right humerus of red-tailed hawk showing the thin cortical bone and a bit of trabecular bone. Right: Decomposed right humerus with exposed trabecular bone .



Left: Proximal end of left ulna of barred owl, sectioned to show marrow cavity and trabecular bone. Right: Distal end of broken left humerus of barred owl, showing the lattice of trabeculae that act to strengthen the bone.

Distinctive Avian Bones

Skulls and mandibles are bones easily identified as avian, but several post-cranial elements are also distinctive. In the avian form of the vertebrate "hand," several carpals and metacarpals have fused to form the carpometacarpus. The violin-bow-shaped carpometacarpus is a bone unique to birds. The violin-bow-shaped carpometacarpus is a bone unique to birds. Clavicles in most birds have fused to form the furcula (wishbone), which acts as a spring to hold the shoulder joints apart during wing movement. In flying birds, the sternum possesses a prominent keel where flight muscles attach. While the necks of birds are very flexible, the backbones and ribs are strong and rigid. A number of vertebrae (some thoracic, the lumbar, the sacral, and some



Left carpometacarpus of golden eagle.

Skeleton



Furcula of turkey vulture.



Pelvis of bald eagle (ventral view).

caudal) have fused together to form the synsacrum, which in turn has fused with the ilium, ischium, and pubis to form the pelvis. Each rib has an uncinat process that articulates with an adjacent rib to further increase rigidity of the axial skeleton.

The appendices of this guide include photos of articulated skeletons, and the visual glossary identifies the bones mentioned here.



Axial skeleton of ferruginous hawk (right side view), showing the sternum, ribs, vertebrae, pelvis, and tail (pygostyle). One vertebral rib with its uncinat process is highlighted.

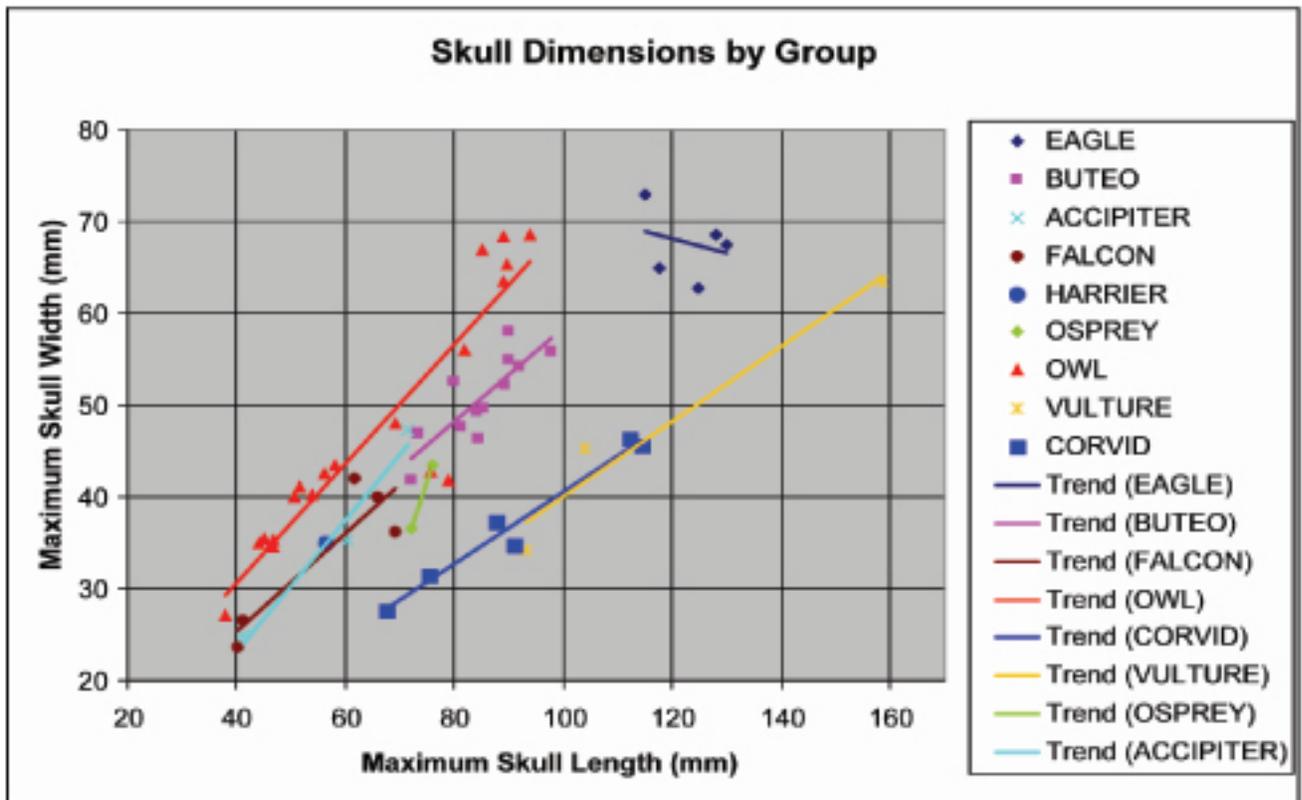
Measurements

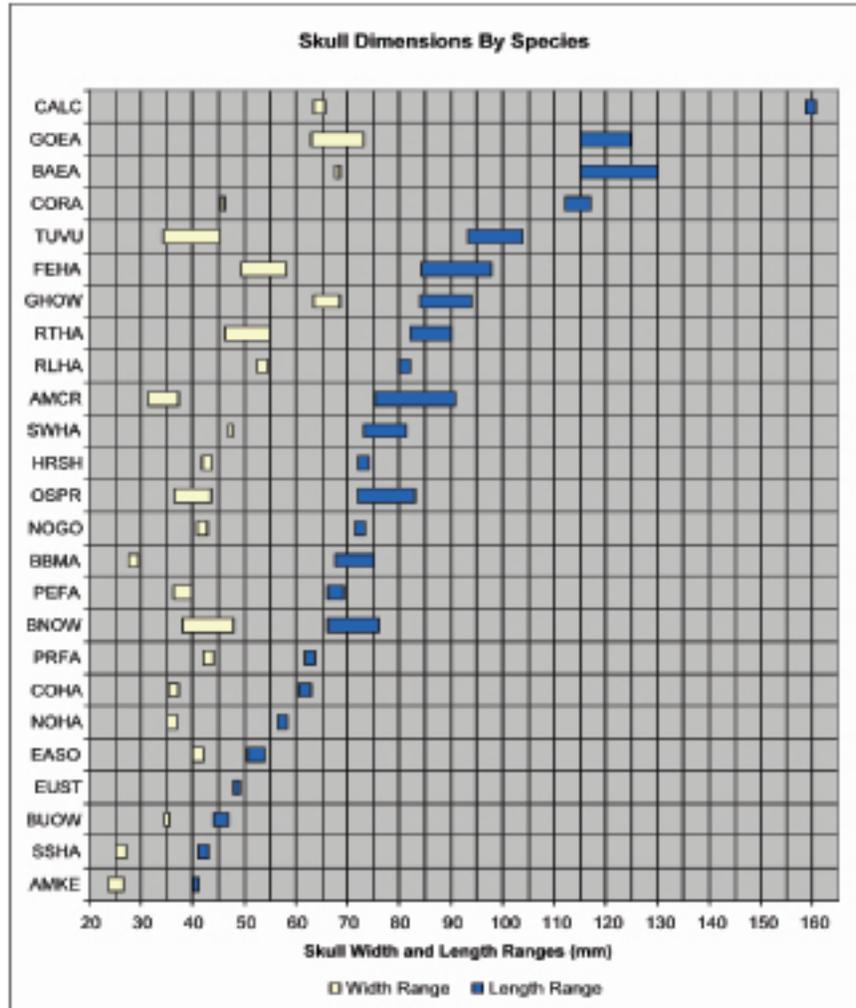
When partial skeletons are recovered, measurements of individual bones may provide enough information to identify the group, or in some cases the species. If the skull is available, measurements of maximum length and width may be plotted on the skull charts to determine the possible groups and species. Comparisons with the skull photos in this guide may be used to help confirm identification. Measurements of post-cranial bones may be plotted on the other charts to suggest possible species. Taking measurements of several bones can be more useful in identifying the species. For example, the length ranges for radius and ulna are very comparable for the golden eagle and bald eagle, but they have non-overlapping ranges for femur length.

These charts include those avian species most likely to be involved with electrocution on power lines. Be aware that not all possible species are represented, and that you may encounter a specimen that does not match any of those included here. Other avian fatalities found in association with electrical lines and structures include woodpeckers, nesting passerines, ducks, geese, and herons. An excellent reference for measurements and key characteristics of the post-cranial avian skeleton is *Avian Osteology* by Gilbert, Martin, and Savage (1996).

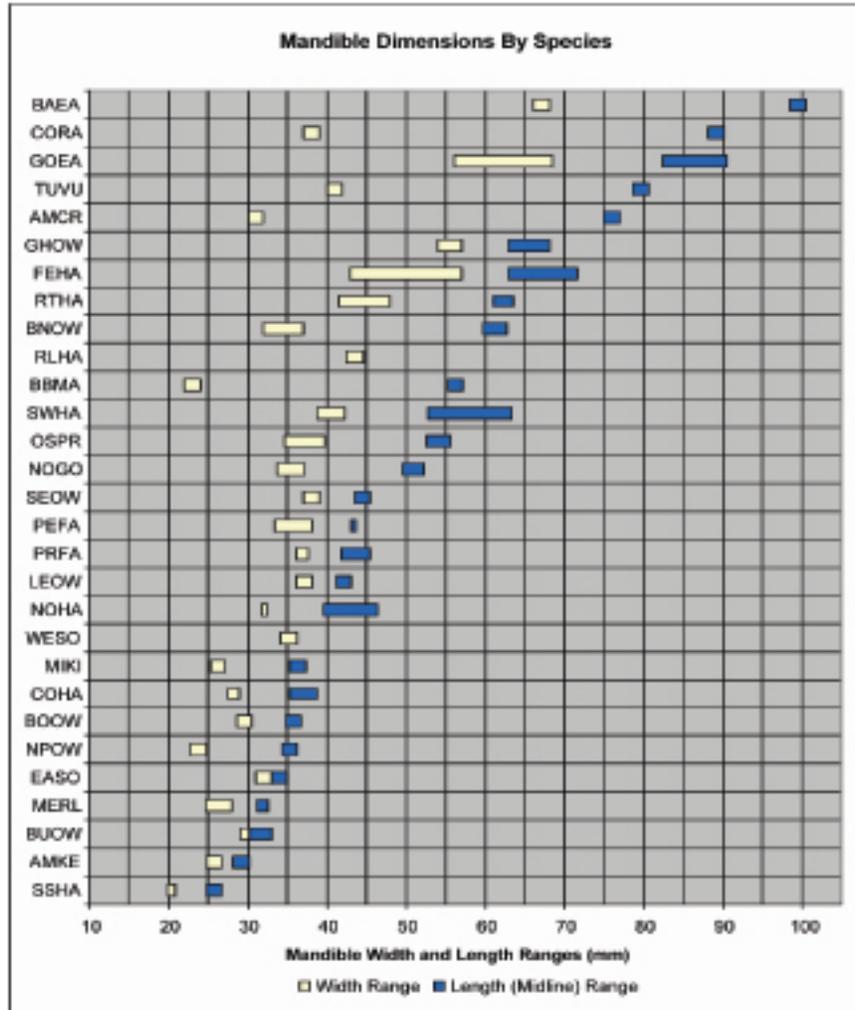
The charts are labeled with abbreviations for species names, using the codes provided in the North American Bird Banding Manual (Gustafson, Hildenbrand, and Metras 1997). The appendices of this guide include a list of species abbreviations, a visual anatomical glossary, and a glossary of terms. For more information on avian anatomy, Proctor and Lynch (1993) provides a good reference.

The sample sizes for the skull and mandible measurements here are very small ($1 < n < 4$), so size variation within a species may be greater than indicated by these charts. The keratinous bill sheath (rhamphotheca) of the skull was absent in most of these specimens. Skulls with the bill sheath intact will be slightly longer. The other charts are based on data from Gilbert, Martin, and Savage (1996), and those sample sizes typically range between 4 and 20.





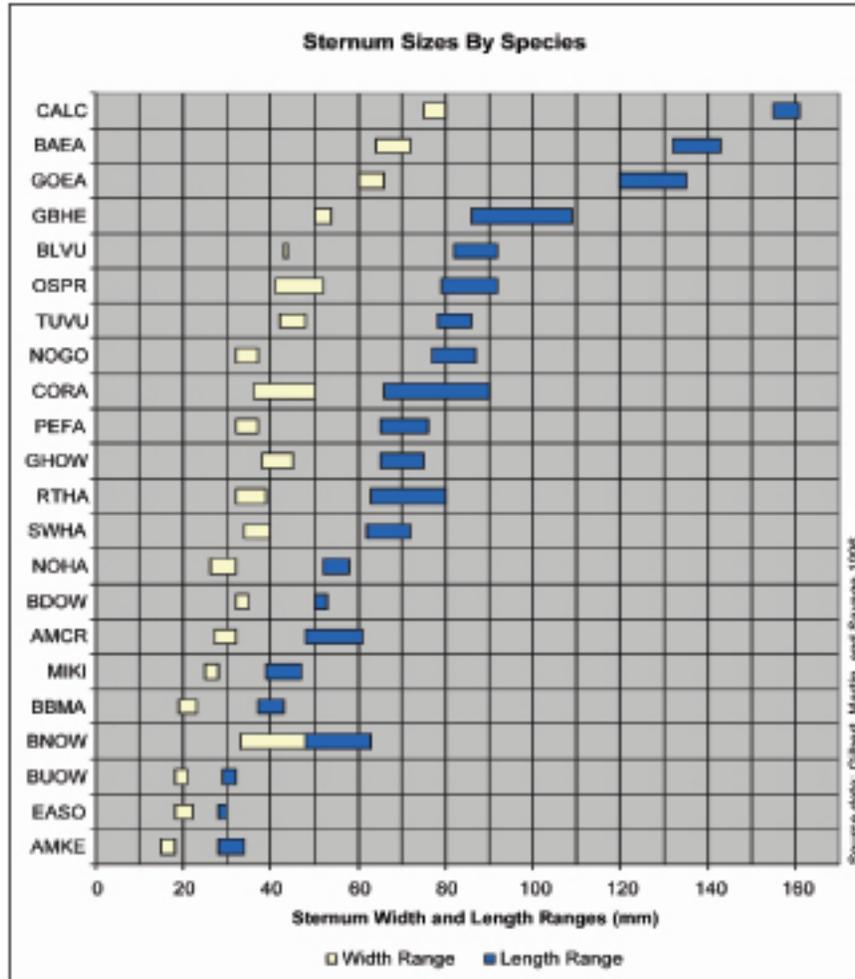
Measurement of maximum skull length and width.



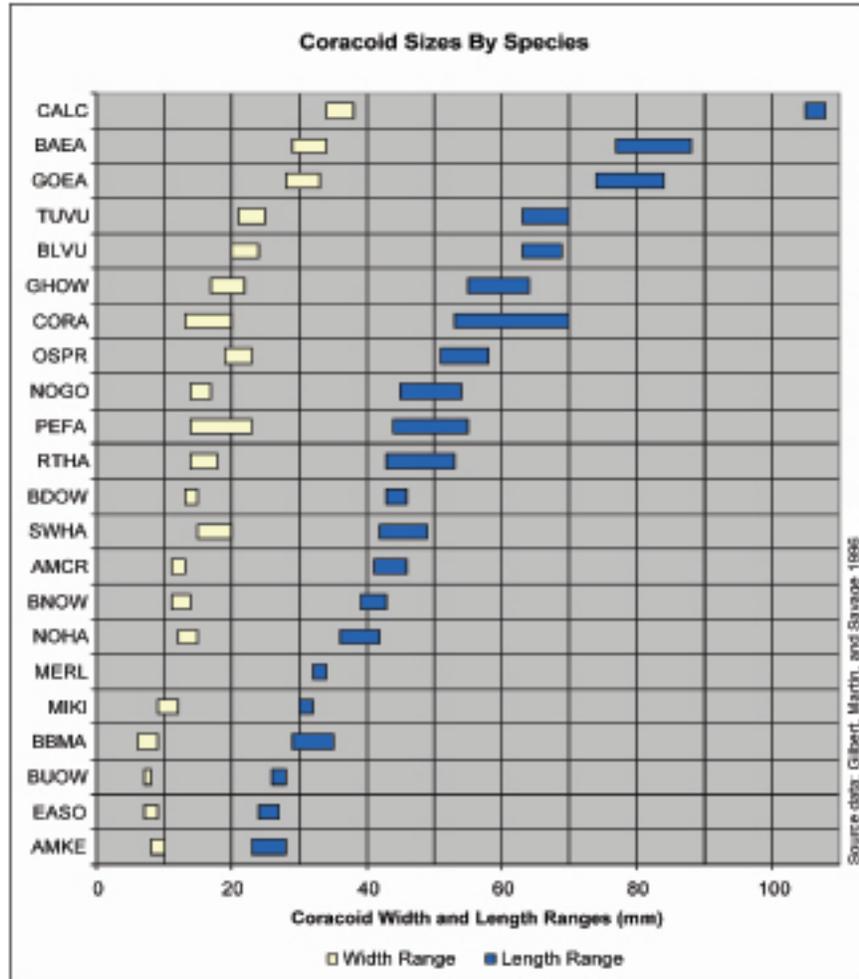
Notes: Sample sizes are small, variation within a species is greater than indicated. The keratinous bill sheath (rhamphotheca) of the mandible was absent in these specimens. Specimens with the bill sheath intact will be slightly longer.



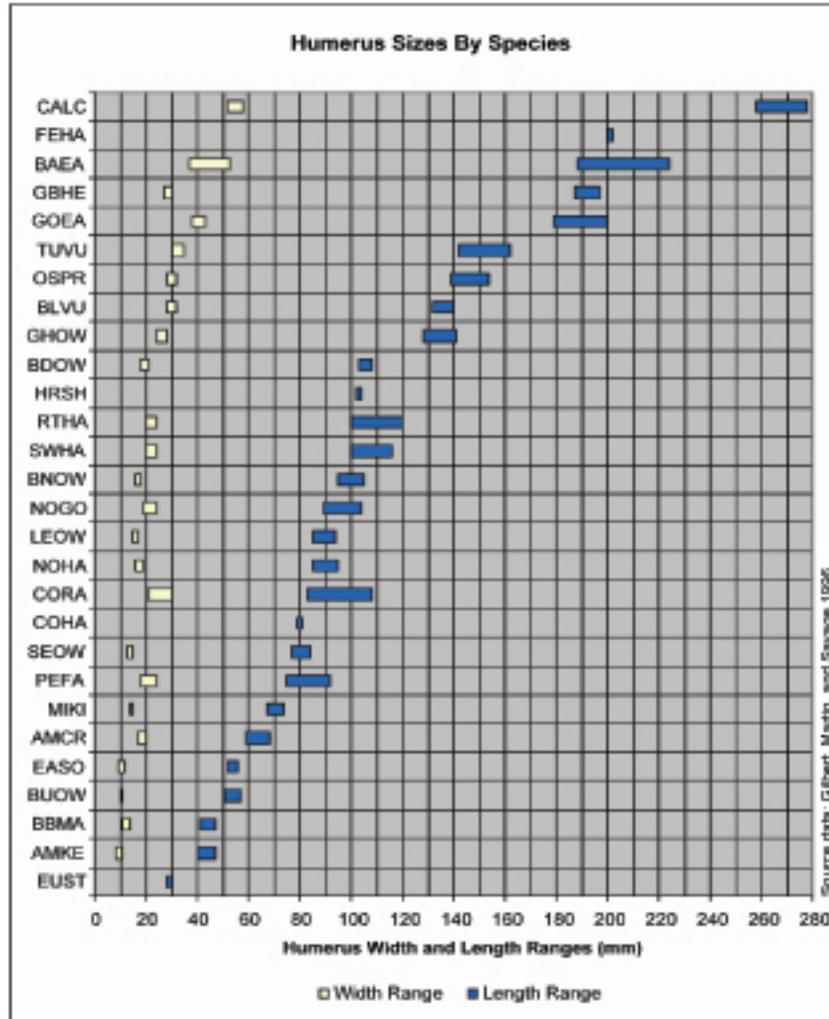
Mandible of barn owl.



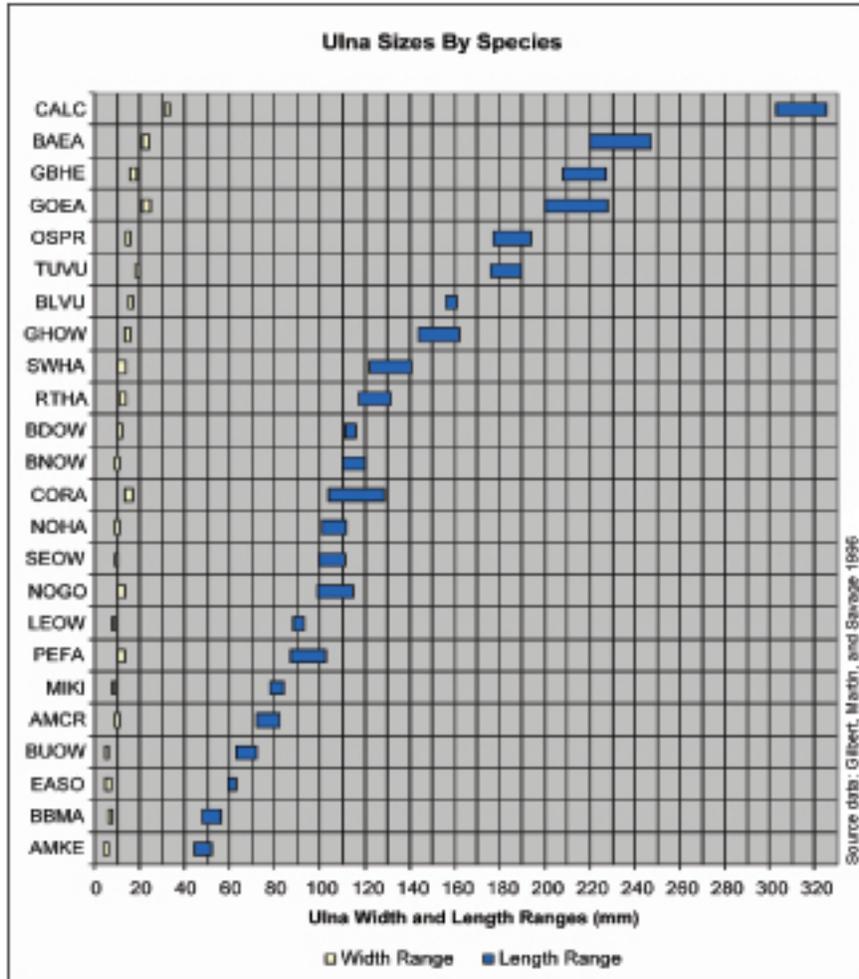
Sternum of bald eagle showing prominent keel (ventral and right side views).



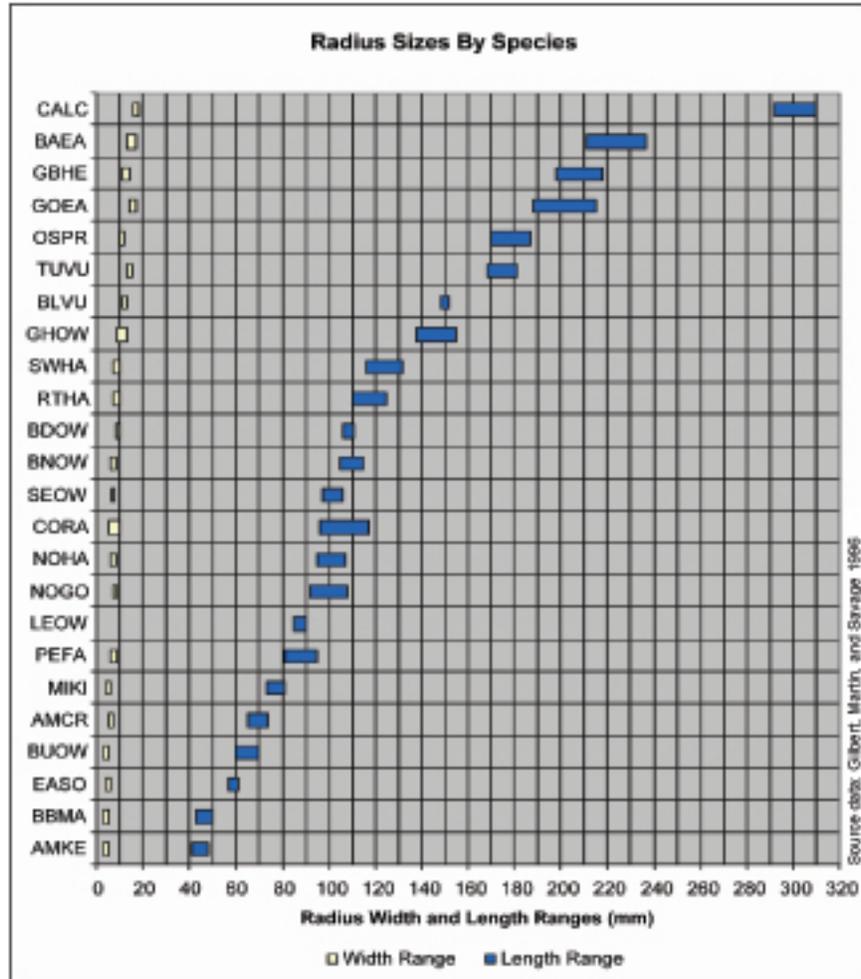
Right coracoid and scapula of golden eagle. In birds, coracoid bones act as pillars to support the shoulder. (See the visual glossary and articulated specimens in the appendices.) The scapula is a long, blade-like bone which extends horizontally back from the shoulder joint. After decomposition of the carcass, these two bones are often found connected together after other bones have become separated.



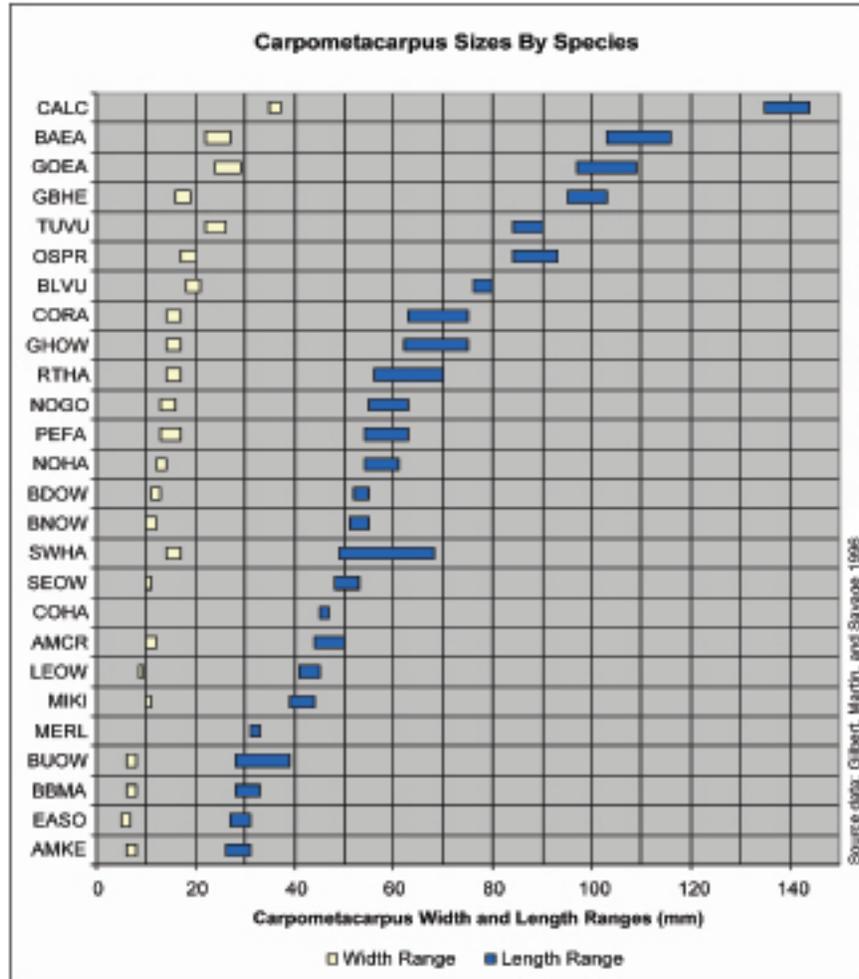
Left humerus of bald eagle.



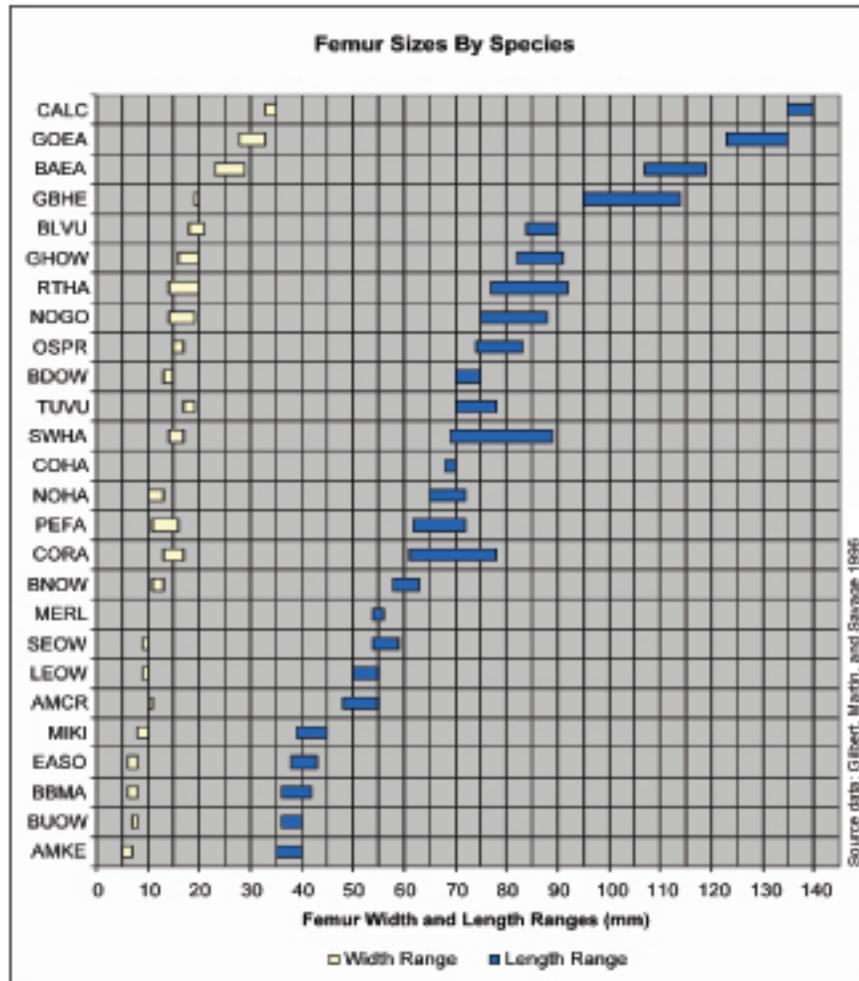
Right ulna of turkey vulture. (The quill knobs are more pronounced in vultures.)



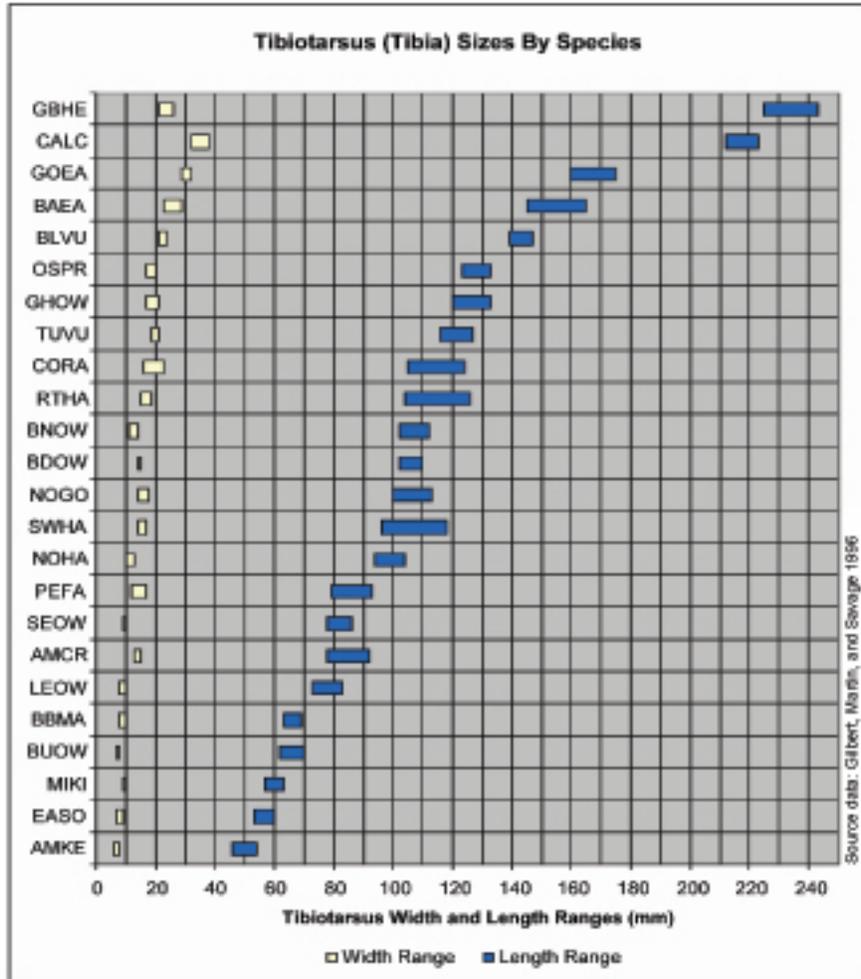
Right radius of golden eagle.



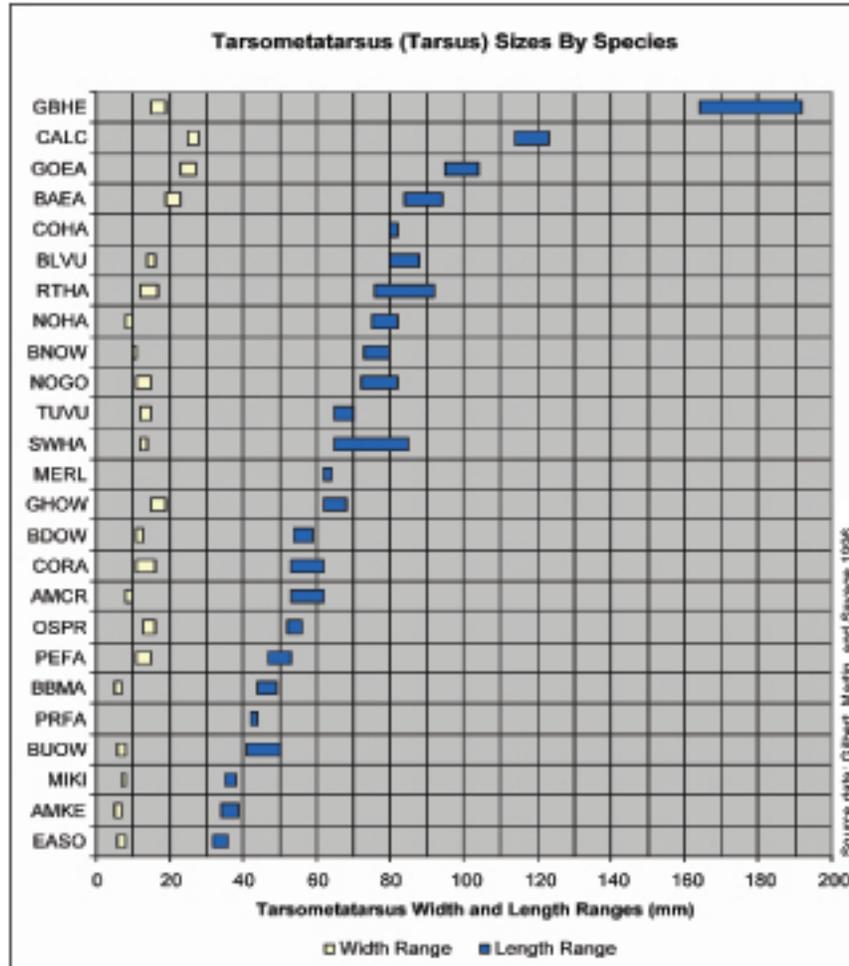
Left carpometacarpus of turkey vulture.



Right femur of golden eagle.



Right tibiotarsus (tibia) and fibula of great horned owl.



Right tarsometatarsus (tarsus) of great horned owl.

Talons

Talon form and length may be of additional help in identifying species. In most raptor species, talon lengths vary by toe position. The talons of the hallux (hind or first toe) and second toe (inner) are typically the larger, while the talon of the fourth toe (outer) is usually the smallest. Osprey talons are more uniform in size.

Notable talon characteristics are included in species summaries.



Size comparison of casts of some common talons (terminal phalanges of foot). Toe positions are not known.

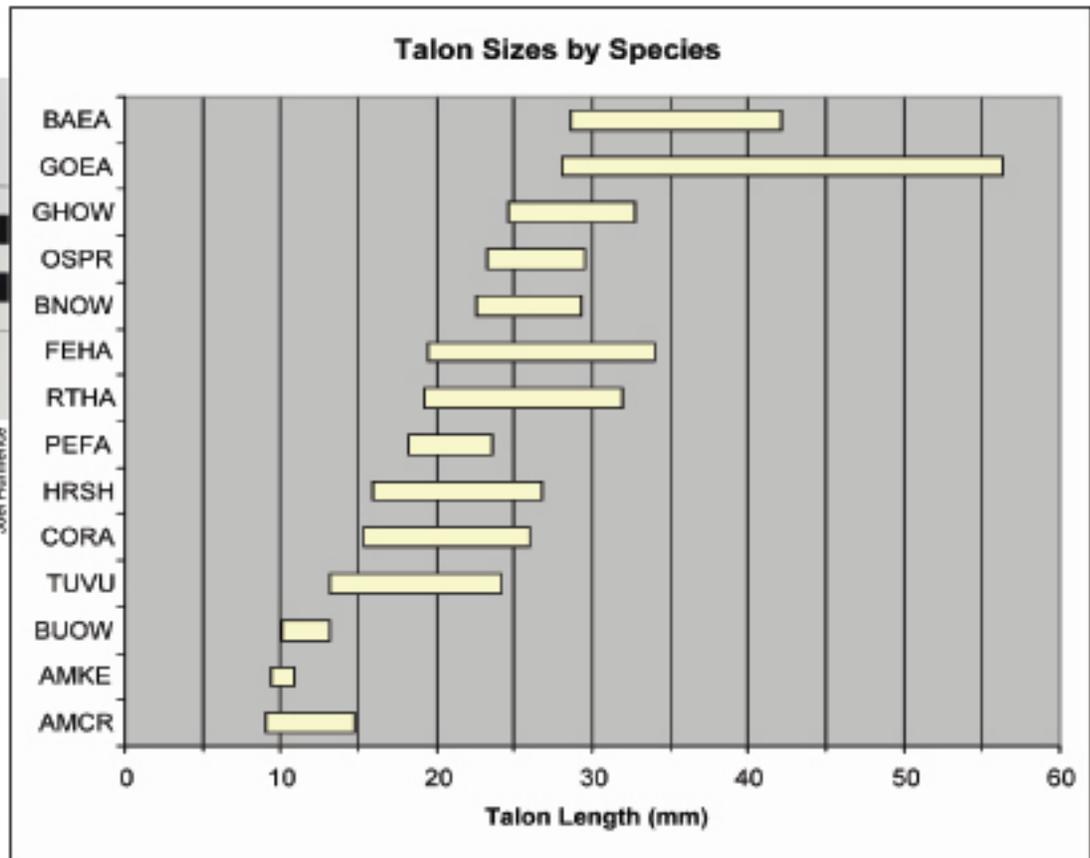
Note: The talons measured here still had the keratinous sheath intact



Measurements of talon (terminal phalanx) length. Measurements with flesh and feathers will be slightly larger than those of loose talons.



Talons from one foot of a golden eagle. Note the range of talon sizes for a single specimen. The talon of the inner toe is the largest, followed in order of decreasing size by hallux, middle, and outer toes.



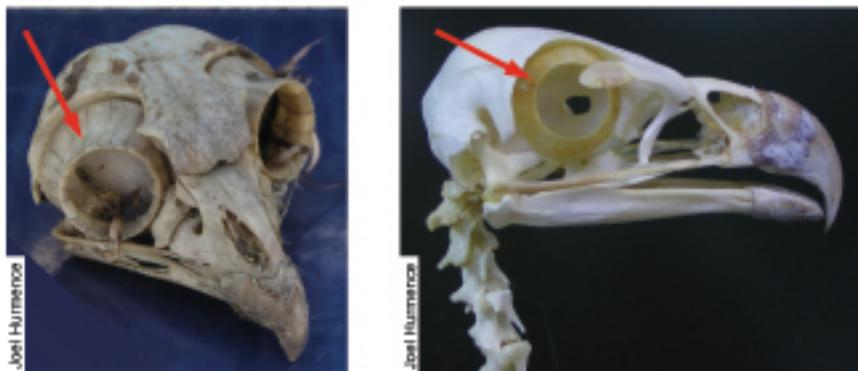
Species by Group

This section presents cranium photos and identification tips for selected species presented by group: Vultures, osprey, kites and harriers, accipiters, buteos, eagles, falcons, owls, and corvids. The species are presented in the taxonomic order defined by the American Ornithologist's Union Check-list (American Ornithologist's Union 2003), except that the bald eagle is grouped with the golden eagle.

Each skull is pictured in inferior, superior, and right side views. Please interpret the scales shown as approximate, due to distortion of the images resulting from the camera's close-up perspective on a three-dimensional skull against the photographic scale. Foreground features are exaggerated in size by their relative proximity to the lens. The different orientation and tilt of a skull in the three views produce slightly different apparent sizes.

One individual represents each species here, and you may not find an exact match between pictured specimens and examples found in the field. There is always variation within a species, due to genetics, sexual dimorphism, and age. There are over 30 bones in avian skulls, and the sutures between individual bones are still visible in immature birds. The specimens pictured are adults, and the sex is noted when known.

Birds have a bony structure, the sclerotic ring, which encircles and supports the eye. Note that the sclerotic rings are missing on most of the skulls pictured here, and they are usually not found in the field.



Two specimens with sclerotic rings intact: great horned owl (left) and golden eagle.



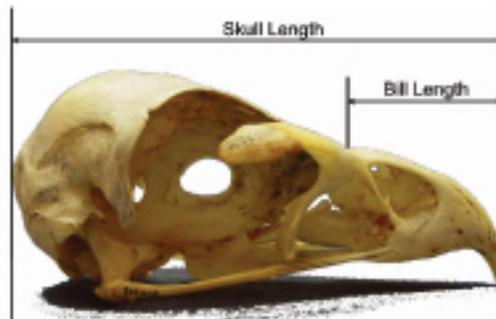
Two great horned owl skulls found at one electrical pole. Note the variation between the skulls of these two individuals.

Another structure found in many raptor species, but seldom recovered in the field is the superciliary shield. This bony plate extends outward over the eye socket, providing a ridge which shades the eye.

Bill length / skull length ratios, when provided, are taken from Elbroch, Marks, and Boretos (2001), augmented by our measurements. A range of dimensions is given, but sample sizes were not provided. Variation within the species may be greater than the range shown.

The diagram at right describes skull length and bill length measurements as defined by Elbroch, Marks, and Boretos (2001).

Note that all measurements are horizontally linear, rather than along the curve of the skull or bill.



Species by Group

Typical feather lengths, when provided, are also taken from Elbroch, Marks, and Boretos (2001). For each type of feather, lengths vary according to feather position and individual variation. Feather photos appear courtesy of Hawks Aloft, Inc.

Additional identification tips are taken from personal observation and other sources, including Coues (1903) and Johnsgard (1988, 1990). A visual glossary of anatomical terms is included in the appendices of this guide as an aid to understanding the descriptions.

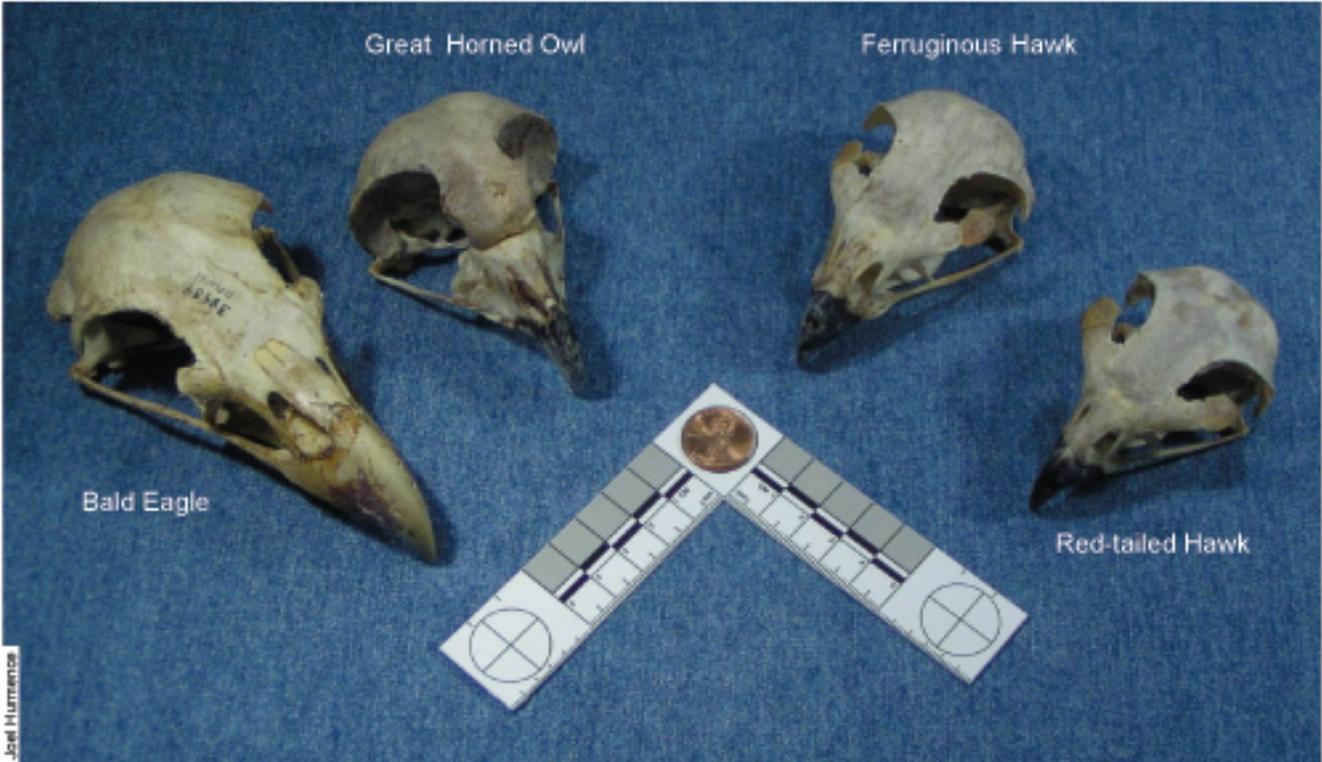
The process of identification also should include consideration of information not covered by this guide, but available from other sources, such as Wheeler (2003) and Sibley (2000). The location of the remains, along with other evidence present (such as pellets or prey remains), can be compared with the known geographic range, typical habitat, and typical prey associated with candidate species.

Included with this guide are photos of articulated skeletons of turkey vulture, golden eagle, great horned owl, and red-tailed hawk. The last three are the species most often documented in electrocution records in the western United States (Harness and Wilson 2001).

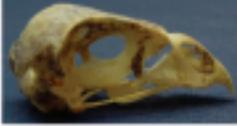


Articulated skeleton of ferruginous hawk. Additional photos of articulated specimens can be found in a subsequent section of this guide.

Species by Group



Comparison of skulls. The sclerotic rings are missing on all specimens, and also the superciliary shields of the bald eagle.

<p>Vultures</p> 	<p>Large, dark scavengers with featherless, brightly-colored heads. Skull is very narrow for its length. No superciliary shield. Bill long, and contracted toward base. Nostrils very large with no bony septum. Front toes very long, hind toe elevated and very short. Talons comparatively long, little curved and weak. Prominent quill knobs on ulna.</p>
<p>Osprey</p> 	<p>Large, nearly eagle-sized raptor of open water habitats. Feathers boldly marked with black and white. No superciliary shield. Bill is constricted at cere, and bill edge has no tooth. Nasal openings of skull are oval; fleshy nostrils slit-like and closeable. Spiny pads on fleshy undersides of toes. Talons large, of equal length, and rounded in cross section. Outer (fourth) toe is reversible.</p>
<p>Kites</p> 	<p>Diverse group. White-tailed and Mississippi kites are small to medium-sized, wings long and pointed, bill and feet small. Superciliary shield present. Upper bill strongly curved and overhanging. Nostrils not circular, no central tubercle. Talons of white-tailed kite are round or flat-bottomed. Mississippi kite has lobe ("tooth") on upper bill.</p>
<p>Harrier</p> 	<p>Medium-sized, slim, long-tailed hawk of wetlands and open country. Feathers cinnamon, tawny, brown, or gray. Owl-like feathered facial disc and large ear openings in flesh. Superciliary shield prominent. Nostrils not circular, no bony tubercle. Tibiotarsus long and slender, approx. equal to tarsometatarsus in length. Middle toe shorter than tarsus. Talons large, curved, concave undersides.</p>
<p>Accipiters</p> 	<p>Small to medium-sized forest hawks. Short, rounded wings and long, narrow tail. Small head, long legs/feet. Superciliary shield prominent. Bill short, robust, high at base. Cutting edge is toothless but usually not smooth. Tibiotarsus approx. equal to tarsometatarsus in length. Tarsometatarsus slender, longer than middle toe without talon. Talons with concave undersides.</p>

<p>Buteos</p> 	<p>Medium to large-sized hawks with long, broad wings. Tails of medium length and can appear broad. Plumages vary greatly. Superciliary shield prominent, consisting of two pieces. Bill without toothing or notching. Nostrils not circular and no bony tubercle. Tarsometatarsus obviously shorter than tibiotarsus. Talons with concave undersides.</p>
<p>Eagles</p> 	<p>Very large. Superciliary shield prominent, consisting of two pieces. Bill without toothing or notching. Nostrils not circular and no bony tubercle. Tarsometatarsus obviously shorter than tibiotarsus. Talons with concave undersides. Bald eagle: Larger yellow bill, and lower half of tarsus without feathers. Golden eagle; Smaller dark bill, tarsus feathered to toes.</p>
<p>Falcons</p> 	<p>Small to medium-sized hawks with long, pointed wings; tails of medium length and generally taper toward the tip. Nostrils circular, with a central bony tubercle. Superciliary shield in one large piece. Cutting edge of bill sheath is "toothed" and mandible is notched. Tarsometatarsus is shorter than tibiotarsus. Middle toe is very long. Talons with concave undersides.</p>
<p>Owls</p> 	<p>Mostly nocturnal. Feathered facial disk. Fringe on leading edge of primary feathers. Skull wide and short. Bulging rise in the forehead area above base of the bill. Ear openings in flesh are large. Bill cutting edges are smooth. Sternum deeply notched in typical owls. Feet usually feathered to or on the toes. Outer toe (fourth) is reversible. Talons are round in cross section.</p>
<p>Corvids</p> 	<p>Like other passerines, skull is very narrow for its length. The bill is long, not hooked, and does not have a bulbous tip as seen in vultures. Sternum has bifurcated manubrium.</p>

Also note the chart "Skull Dimensions by Group" on page 20.

Vultures*Turkey Vulture (TUVU)**Cathartes aura*

Order Ciconiformes, family Cathartidae.

Specimen: Adult, sex undetermined

Vulture traits: Relative to raptors, skull is very narrow for its length, and has no superciliary shield; bill long and contracted toward base. Nostrils very large and completely perforated (no bony septum). Front toes very long, hind toe elevated and very short. Talons comparatively long, little curved and weak. (Coues 1903:700) Vultures have noticeable quill knobs on the ulna where secondary feathers attach. These knobs are not as pronounced in raptors.

Turkey vulture traits: Large, dark bird with naked red head and pale bill.

Habitat: Open country and dumps, occasionally in urban areas.

Skull Length: 93—104 mm

Bill Length: 41—43 mm
(43-44% of skull length)

Feather lengths (typical)

Primary: 47 cm

Secondary: 16 cm

Tail: 29 cm



The long toes of a turkey vulture



Right ulna of turkey vulture. The quill knobs where the secondary feathers attach are more pronounced in vultures than in birds of prey.



Diagne L. France

California Condor (CALC)
Gymnogyps californianus

Specimen: Adult, sex undetermined

Vulture traits: Relative to raptors, skull is very narrow for its length, and has no superciliary shield; bill long and contracted toward base. Nostrils very large and completely perforated (no bony septum). Front toes very long, hind toe elevated and very short. Talons comparatively long, little curved and weak. (Coues 1903:700) Vultures have noticeable quill knobs on the ulna where secondary feathers attach. These knobs are not as pronounced in raptors.

California condor traits: Size immense. A fleshy comb or crest surmounting the base of the beak. Bill very stout with short cere. Frontal region of skull is slightly depressed below base of bill.

Habitat: Reintroduced in areas of California and northern Arizona.



Photo of cast courtesy of Bones Clones®, www.boneclones.com

Osprey (OSPR)
Pandion haliaetus

Order Falconiformes, family Accipitridae, subfamily Pandioninae.

Specimen: Adult male

Osprey traits: No superciliary shield; eye is flush with the side of the head. Bill edge has no tooth; bill constricted at cere. Nasal openings of skull are oval, while the fleshy nostrils are long, slit-like, and uniquely closeable. Gonyx of the mandible is convex, ascending. Tarsometatarsus is stout and has a bony canal for the passage of the common extensor of the toes, as in most owls. Unlike all other Falconiformes, the outer (fourth) toe is reversible (as in owls). Osprey have spiny pads on the fleshy undersides of the toes, for holding fish. Talons are large, strongly and evenly curved, of equal length, and deeply rounded in cross section. Talon of middle toe sharply grooved on inner face. (Coues 1903:698, Johnsgard 1990)

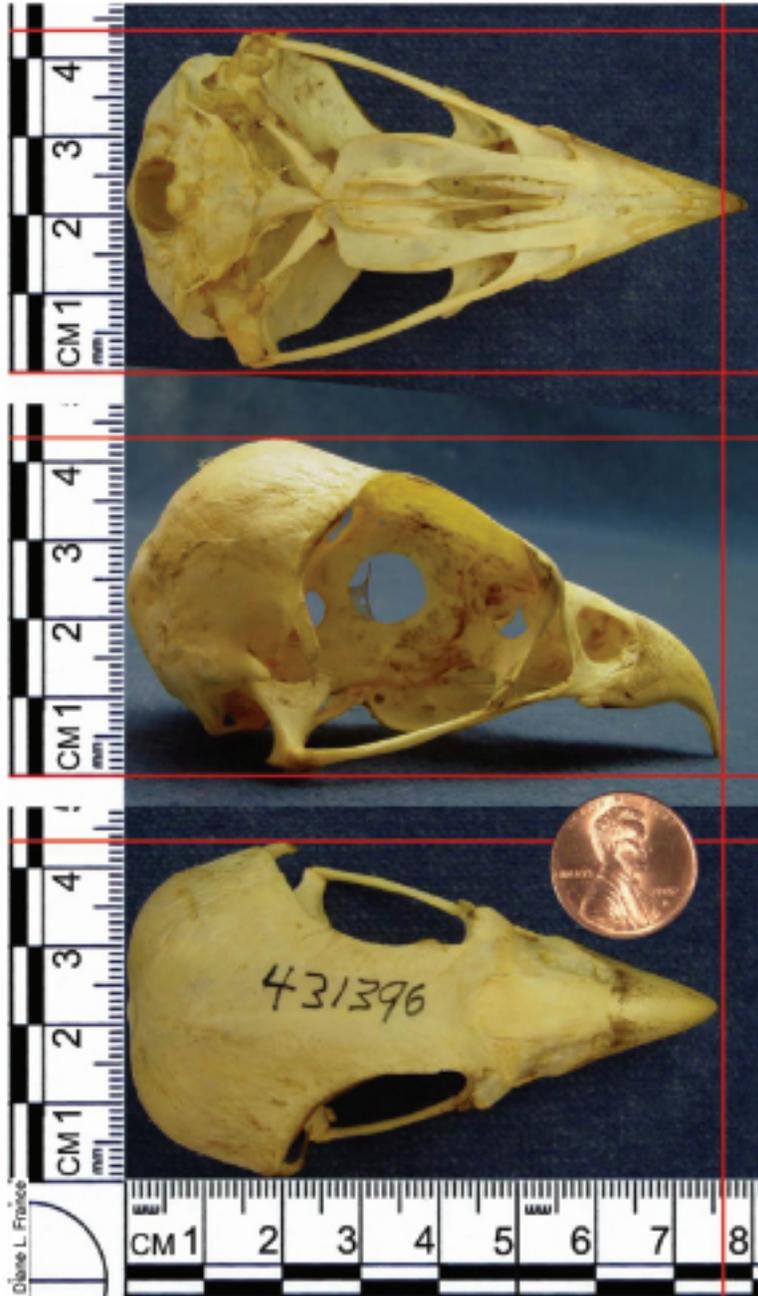
Habitat: Large lakes, rivers, and coast.

Skull length: 72—83 mm
 Bill length: 27—34 mm
 (44-54% of skull length)

Feather lengths (typical)
 Primary: 33—34 cm
 Secondary: 21.9 cm
 Tail: 23.5—24.4 cm

Osprey talons are uniform in size, and deeply rounded in cross section (Johnsgard 1990).





Kites

Order Falconiformes, family Accipitridae, subfamily Accipitrinae.

Kite traits: Long, pointed wings. Superciliary shield present. Feet and bill small. Nostrils not circular nor with central bony tubercle. Bony nasal septum incomplete. Tarsometatarsus is much shorter than tibiotarsus, and is approximately equal in length to middle toe without talon.

White-tailed Kite (WTKI) (formerly black-shouldered kite)
Elanus leucurus

No specimen available. Mississippi kite provided as example kite.

White-tailed kite traits: Small kite, gray and white with black on shoulders. Tail double rounded. The combination of blackish shoulder feathers and talons that are flattened or slightly convex (rounded outward) on their undersides serve to identify this species. (Coues 1903:653, Johnsgard 1990:122)

Habitat: Grasslands with scattered trees, near marshes, along roads.

Mississippi Kite (MIKI)
Ictinia mississippiensis

Specimen: Adult female

Mississippi kite traits: Medium-sized kite, grayish in color. Tail square or slightly forked. Cutting edges of upper bill sheath have "tooth." First joint of middle toe fused with the next. Talons short and strongly curved. The combination of narrow, pointed wings and a long (15—17.5 cm) blackish or black-banded tail that is about half the length of the wing provides a means of identifying this species. (Coues 1903:653, Brown and Amadon 1968:254, 256, Johnsgard 1990:136)



Mississippi kites, like other *Ictinia* kites, have a "tooth" on each cutting edge of the upper bill sheath. This has the appearance of a falcon, but kite "teeth" are not as pointed, kite mandibles are not notched, and kite nostrils are not circular.

Habitat: Open woodlands, wooded streams, swamps.



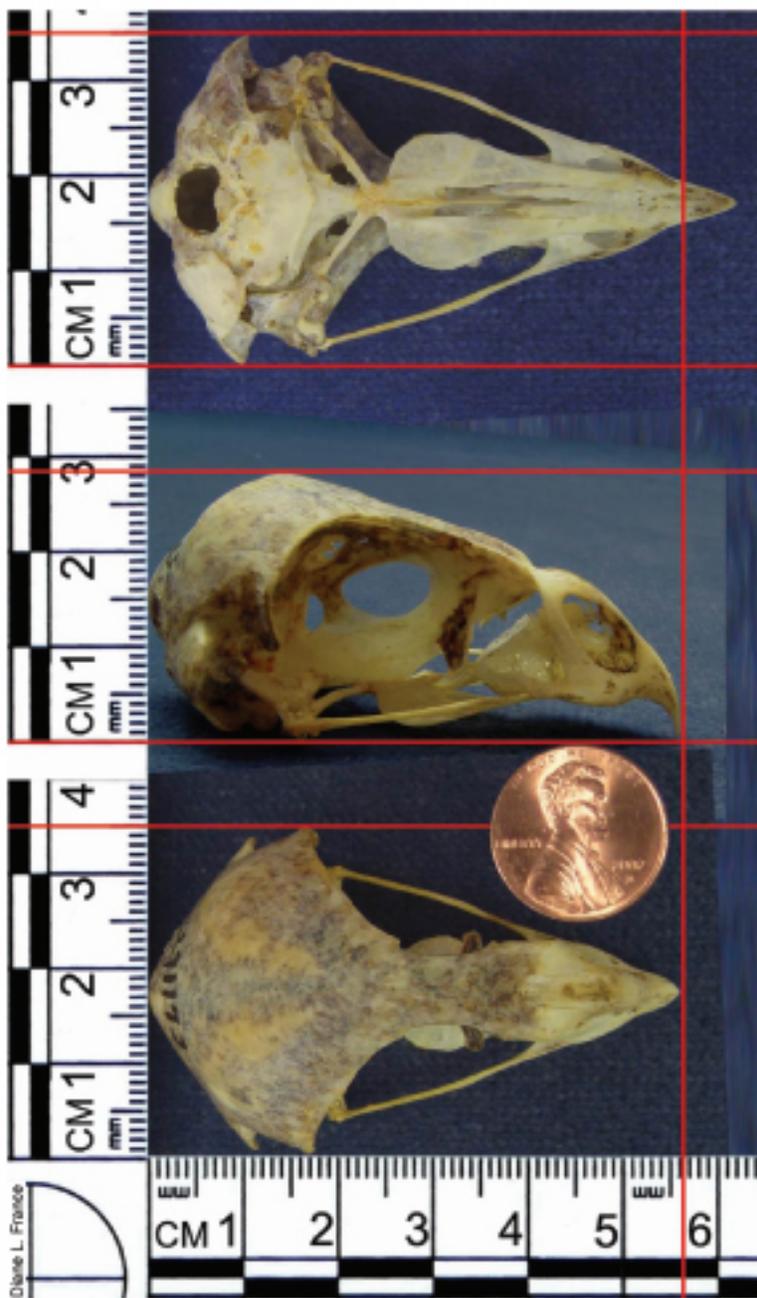
Harriers*Northern Harrier (NOHA)**Circus cyaneus*

Order Falconiformes, family Accipitridae, subfamily Accipitrinae.

Specimen: Adult, sex undetermined. Superciliary shields (and sclerotic rings) are missing

Distinguished by an owl-like disk of facial feathers and unusually large ear openings in the flesh (hidden by facial feathers). Superciliary shield prominent. Bill rather weak, not "toothed" or notched. Nasal septum less complete than in falcons, nostrils not circular and have no central tubercle (as in falcons). Fleshy nostrils ovate-oblong, nearly horizontal. Tibiotarsus long and slender, and approximately equal to tarsometatarsus in length. Toes slender, the middle with its claw much shorter than tarsus. Basal web between outer and middle toes. Talons very large and sharp, much curved, and with concave undersides. (Coues 1903:651-652)

Habitat: Open fields, grasslands, prairies, fields, and marshes.



Accipiters*Sharp-shinned Hawk (SSHA)**Accipiter striatus*

Order Falconiformes, family Accipitridae, subfamily Accipitrinae

Specimen: Adult male

Accipiter traits: Small head, shortened wings, lengthened tail and legs. Superciliary shield prominent. Bill short, robust, high at base. Cutting edge is toothless but usually not smooth. Nostrils broadly oval with no central tubercle. Tibiotarsus approximately equal to tarsometatarsus in length. Tarsometatarsus slender, longer than middle toe without claw. (Coues 1903:657) Talons with concave undersides.

Sharp-shinned hawk traits: Tarsometatarsus feathered about 1/3 way down in front, or less, and quite slender. Toes long and slender, the outer much webbed at base and padded underneath; inner talon much larger than middle one, approximately equal to the hallux (hind talon). (Coues 1903:658) The sharp-shinned hawk has a small body (under 225 g), with short, rounded wings (16-21 cm), and a barred tail that is about 80 percent as long as the wings, distinctly square-tipped, and no more than 18 cm long (Johnsgard 1990:166).

Habitat: Mixed deciduous and coniferous woods, also near bird feeders.

The sharp-shinned hawk is a smaller version of the Cooper's hawk. In the hand, size is diagnostic. There is no overlap in ranges of wing length or total length (bill to tail) between the species (Coues 1903:658, Kaufman 1990:52). Their skull size ranges do not overlap.

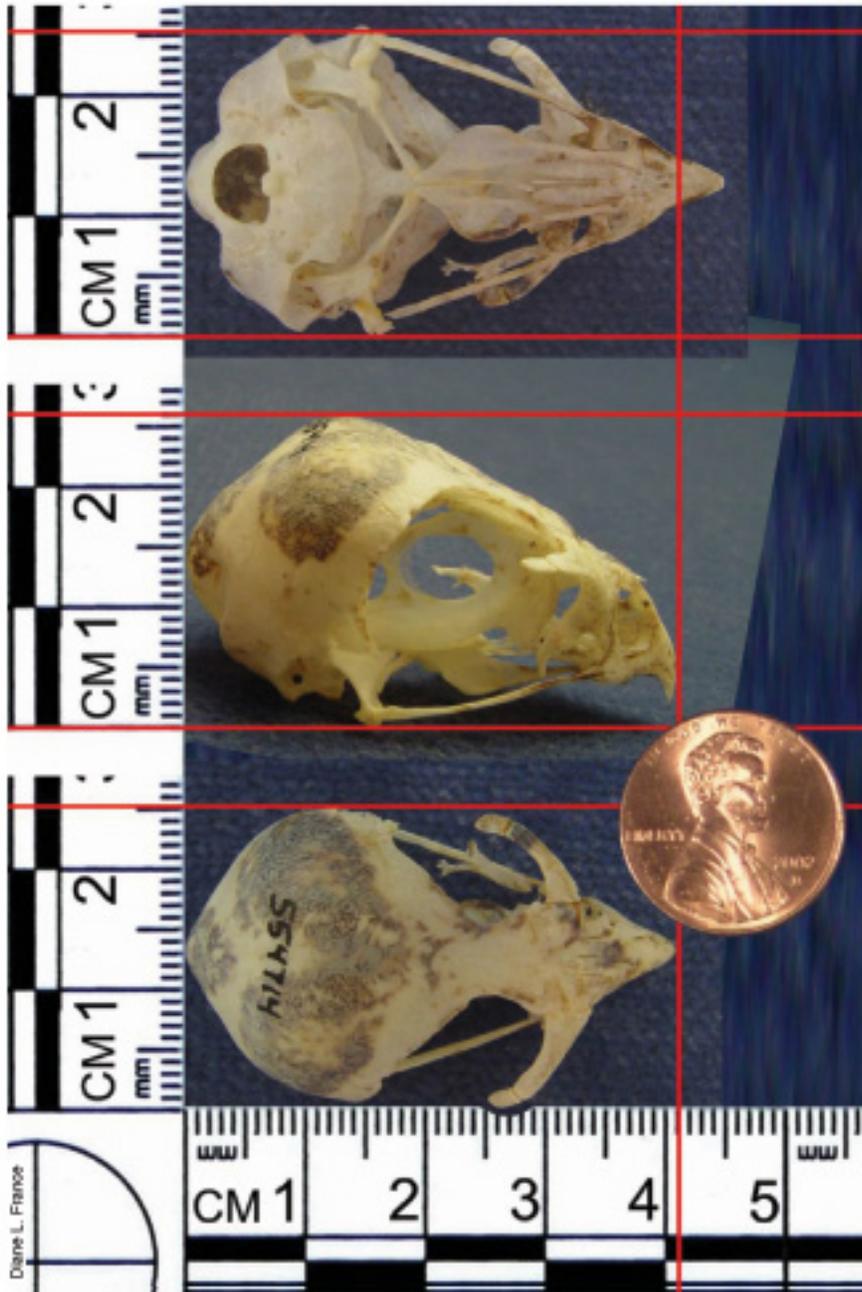
Skulls of sharp-shinned hawks are similar in size to skulls of American kestrels and merlins, but kestrels and merlins have circular nostrils and "teeth" on the cutting edges of the upper bill sheath.

Feather lengths (typical)

Primary: 9.2—16.5 cm

Secondary: 10.2 cm

Tail: 16.8 cm



Cooper's Hawk (COHA)
Accipiter cooperii

Order Falconiformes, family Accipitridae, subfamily Accipitrinae

Specimen: Adult male

Accipiter traits: Small head, shortened wings, lengthened tail and legs. Superciliary shield prominent. Bill short, robust, high at base. Cutting edge is toothless but usually not smooth. Nostrils broadly oval with no central tubercle. Tibiotarsus approximately equal to tarsometatarsus in length. Tarsometatarsus slender, longer than middle toe without talon. (Coes 1903:657) Talons with concave undersides.

Cooper's hawk traits: Tarsus feathered about 1/3 way down in front, or less, and about twice as thick as tarsus of sharp-shinned. Toes long and slender, the outer much webbed at base and padded underneath; inner talon much larger than middle one, approximately equal to the hallux (hind talon). (Coes 1903:658). Medium body size (300—700 g), with relatively short, rounded wings (21.4—27.8 cm), and a long, barred, and slightly rounded tail that is about 85 percent as long as the wing and no less than 18 cm long (Johnsgard 1990:172).

Habitat: Mixed forest and open woodlands. Becoming more common in suburban areas.

The Cooper's hawk is a larger version of the sharp-shinned hawk. The head of the Cooper's hawk is larger, and also larger relative to the body size. In the hand, size is diagnostic. There is no overlap in ranges of wing length or total length (bill to tail) between the species (Coes 1903:658, Kaufman 1990:52). Their skull size ranges do not overlap.

Skull length: 60—63 mm

Bill length: 27—34 mm (44—54% of skull length)

Feather lengths (typical)

Primary: 13.3—19.4 cm

Secondary: 13.3—17.1 cm

Tail: 23.8—24.5 cm



*Northern Goshawk (NOGO)**Accipiter gentilis*

Order Falconiformes, family Accipitridae, subfamily Accipitrinae

Specimen: Adult, sex undetermined

Accipiter traits: Small head, shortened wings, lengthened tail and legs. Superciliary shield prominent. Bill short, robust, high at base. Cutting edge is toothless but usually not smooth. Nostrils broadly oval with no central tubercle. Tibiotarsus approximately equal to tarsometatarsus in length. Tarsometatarsus slender, longer than middle toe without talon. (Coates 1903:657) Talons with concave undersides.

Northern goshawk traits: Larger size, feet stronger, tarsometatarsus feathered about halfway down in front and on sides, leaving only a narrow bare strip behind (Coates 1903:661). Tarsus thicker than Cooper's hawk. Large (at least 700 g), grayish (adults) to brown (immatures) body, with rounded wings (over 30 cm) and a long tail (over 22.5 cm) that is obscurely barred, slightly rounded, and about 75 percent as long as the wing. (Johnsgard 1990:178)

Habitat: Deep woods with mostly conifers.

Feather lengths (typical)

Primary: 21.6—26.4 cm

Secondary: 15.5—19 cm

Tail: 24—25.4 cm



Buteos

Harris's Hawk (HRSH)

Parabuteo unicinctus

Order Falconiformes, family Accipitridae, subfamily Accipitrinae

Specimen: Adult, sex undetermined

Parabuteo traits: Superciliary shield prominent. Bill high at base, nostrils oval and with eccentric tubercle. Tarsometatarsus lengthened and feathered less than halfway down in front. Tail more than 2/3 as long as wing. Tarsometatarsus obviously shorter than tibiotarsus (Coues 1903:678-679). Talons with concave undersides.

Harris's hawk traits: Identified by combination of nearly naked pale yellow lores and rusty chestnut on wings, including both upper and lower wing coverts (the latter much less evident in immature than adults). (Johnsgard 1990:191)

Habitat: Various habitats from upland desert dominated by saguaros to mesquite, palo verde, and ironwood woodlands in the Colorado River valley.





Red-shouldered Hawk (RSHA)
Buteo lineatus

Order Falconiformes, family Accipitridae, subfamily Accipitrinae

Specimen: Adult female

Buteo traits: Superciliary shield prominent, consisting of two pieces. Bill without the toothing and notching seen in falcons. Nostrils not circular and are without bony tubercle. Tarsometatarsus obviously shorter than tibiotarsus. (Coues 1903:678) Talons with concave undersides.

Red-shouldered hawk traits: Medium-sized buteo of orange-brown color, with reddish patch on shoulders (bend of wings), and bold white spots on dark wings. Tail has 3-4 white bands between wide black bands. Western subspecies is more reddish overall. Immature: little or no orange-brown; plain dark brown, wing patch may not be visible. Immature of California subspecies is similar to adult. (Coues 1903:685-686) This species may be separated from other North American species by its rounded wings (wing 30.9—35.3 cm) that have the inner webs of outer four primaries strongly notched, and have all the primaries and secondaries distinctly barred with white (the bars buffy and less distinct in immatures) on their outer webs (Johnsgard 1990:204).

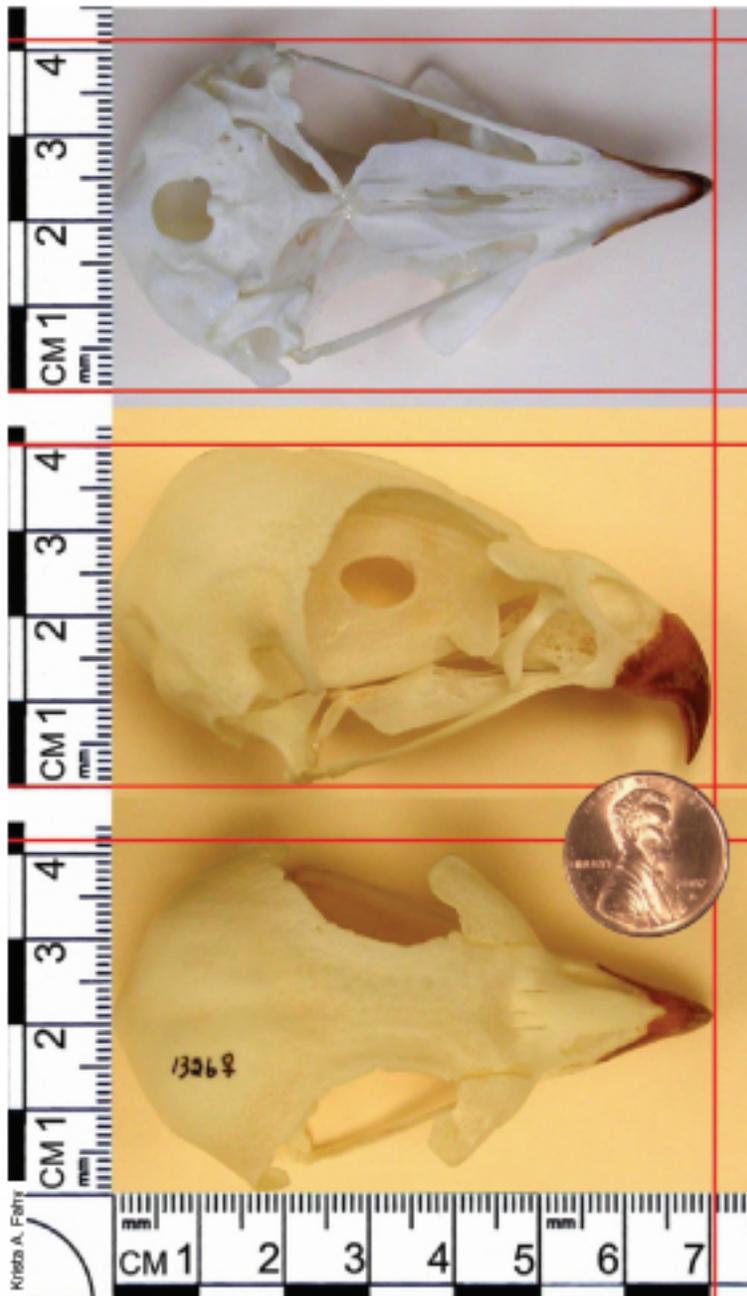
Habitat: Woodlands and swamps. Mixed coniferous-deciduous woodlands, moist hardwood forests, swamps, river bottomlands, and wooded marshy margins (rarely with pure coniferous forests).

Slightly smaller size and not nearly so heavy as red-tailed hawk. Tarsi less feathered than in red-tailed hawk, and the feet are more slender. Red-shouldered hawks also have more extensive and regular streaking on the underparts, and more pronounced spotting of wings on outer webs of primaries.

Feather lengths (typical)

Primary: 27.6 cm

Secondary: 21.0 cm



Krista A. Feist

Swainson's Hawk (SWHA)
Buteo swainsoni

Order Falconiformes, family Accipitridae, subfamily Accipitrinae

Specimen: Adult male

Buteo traits: Superciliary shield prominent, consisting of two pieces. Bill without the toothing and notching seen in falcons. Nostrils not circular and are without bony tubercle. Tarsometatarsus obviously shorter than tibiotarsus. (Coues 1903:678) Talons with concave undersides.

Swainson's hawk traits: This medium-sized buteo is separable from all other North American buteos by the combination of having only the three outer primaries notched on their inner webs, a wing length of over 36 cm, and the tail approximately 60 percent as long as the wing. (Johnsgard 1990:222)

Habitat: Prairies, open arid lands, farmlands, and riparian woodlands.



Feather lengths (typical)
 Primary: 26.7—35.6 cm
 Secondary: 16—17 cm

Note: Primary feathers with notching are not pictured here.



Red-tailed Hawk (RTHA)
Bufo jamaicensis

Order Falconiformes, family Accipitridae, subfamily Accipitrinae

Specimen: Adult female

Buteo traits: Superciliary shield prominent, consisting of two pieces. Bill without the toothing and notching seen in falcons. Nostrils not circular and are without bony tubercle. Tarsometatarsus obviously shorter than tibiotarsus. (Coues 1903:678) Talons with concave undersides.

Red-tailed hawk traits: This highly variable species can be identified by the combination of having the four outer primaries notched on their inner webs, a wing length of 33.7—42.7 cm, and a tail that in adults is reddish brown to pinkish (rarely may be almost white or mottled, streaked, or barred). Light-morph birds have dark patagial stripe along leading edge of underwing. (Johnsgard 1990:240)

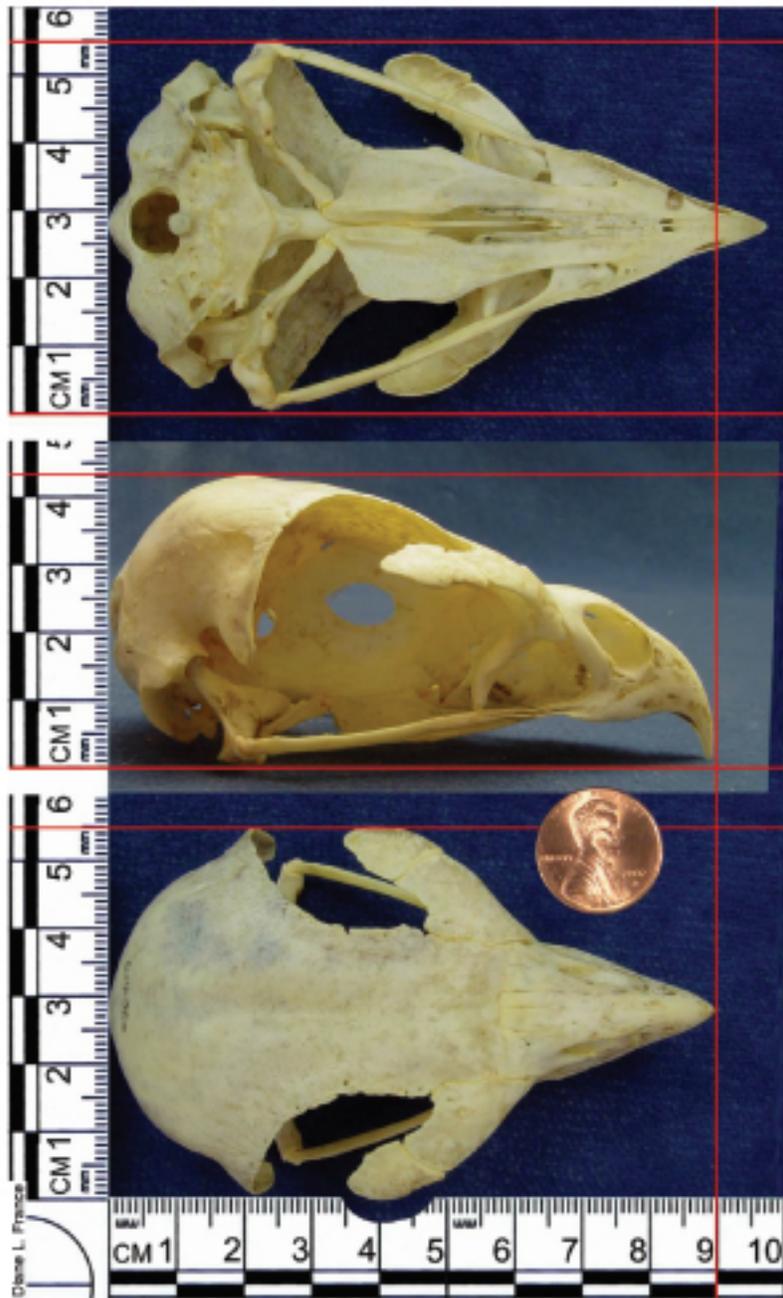
Habitat: Variety of habitats, including suburban areas.



Skull length: 82—90 mm
 Bill length: 28—37 mm
 (43—44% of skull length)

Feather lengths (typical)
 Primary: 20—31 cm
 Secondary: 18—22 cm
 Tail: 20—21 cm

Coloring and barring in the tail feathers of adult red-tailed hawks can vary widely. Some birds have tails with little or no barring, while others have pronounced barring throughout the length of the tail. The tail feathers of all adult red-tailed hawks are rufous-brown in color. Some individuals have a prominent dark band at the lower edge of each tail feather.



Ferruginous Hawk (FEHA)
Buteo regalis

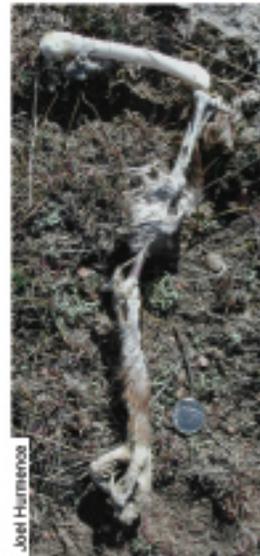
Order Falconiformes, family Accipitridae, subfamily Accipitrinae

Specimen: Adult female

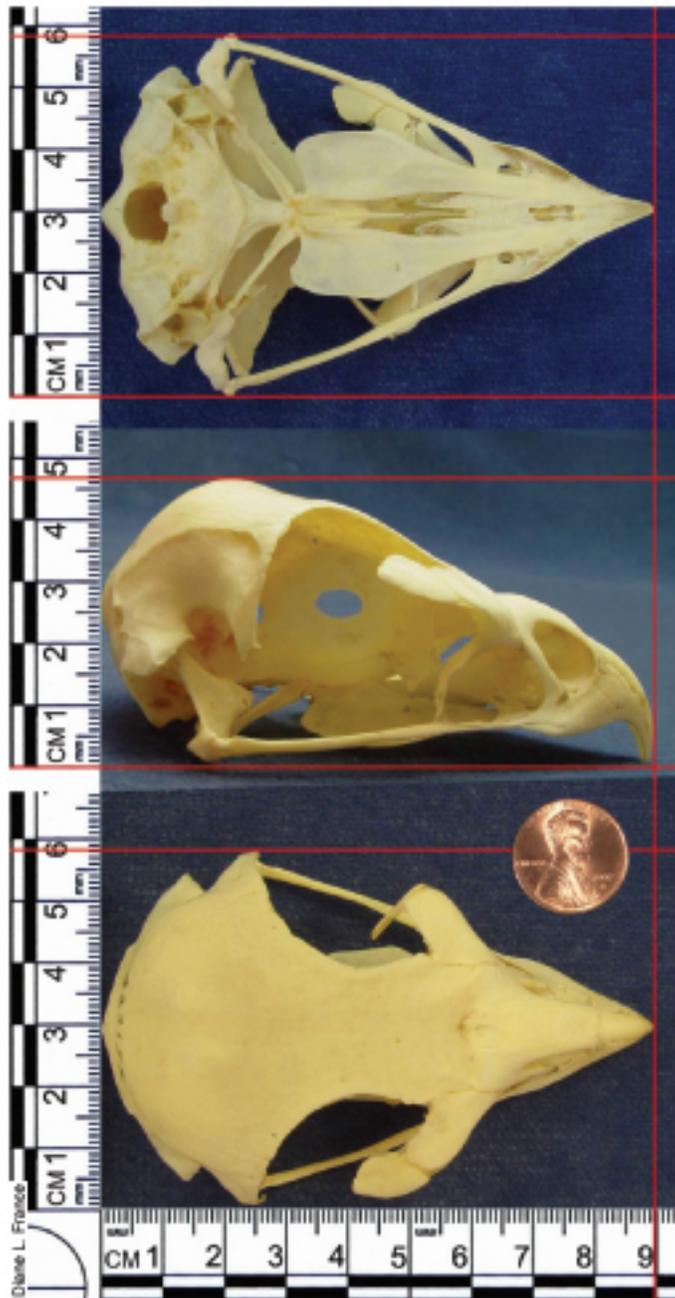
Buteo traits: Superciliary shield prominent, consisting of two pieces. Bill without the tothing and notching seen in falcons. Nostrils not circular and are without bony tubercle. Tarsometatarsus obviously shorter than tibiotarsus. (Coues 1903:678) Talons with concave undersides.

Ferruginous hawk traits: Largest hawk in North America. The combination of feathered tarsi and a gape of at least 42 mm wide at its base distinguishes this species from all other North American raptors except the much larger golden eagle. (Johnsgard 1990:248) Toes are larger than those of rough-legged hawk.

Habitat: Arid open land and grasslands.



The reddish feathers on the tarsometatarsus identifies this leg as that of a ferruginous hawk



Rough-legged Hawk (RLHA)
Buteo lagopus

Order Falconiformes, family Accipitridae, subfamily Accipitrinae

Specimen: Adult, sex undetermined

Buteo traits: Superciliary shield prominent, consisting of two pieces. Bill without the tothing and notching seen in falcons. Nostrils not circular and are without bony tubercle. Tarsometatarsus obviously shorter than tibiotarsus. (Coues 1903:678) Talons with concave undersides.

Rough-legged hawk traits: The combination of feathered tarsi and a gape that is no more than 38 mm wide at the base, distinguishes this from all other North American raptors. (Johnsgard 1990:255) Tarsus feather coloration varies from light to dark, but not reddish. Toes are smaller than those of ferruginous hawk.

Habitat: Summers at the arctic tree line; winters in open country.



Eagles

Bald Eagle (BAEA)

Haliaeetus leucocephalus

Order Falconiformes, family Accipitridae, subfamily Accipitrinae

Bald eagle traits: Of great size and robust form. Superciliary shield prominent. Bill large, long, and very robust. Nostrils oval. Tarsi only feathered to about 1/2 way down. No webbing between outer and middle toes (Coues 1903:695-696). Bill length is much longer than in golden eagle. Adult bald eagle bill, feet, and iris are yellow. Juvenile and subadults have a black bill and cere. The gape color is pale yellow. The absence of feathered tarsi easily separates this species from the similar-sized golden eagle, but not from the other two species of *Haliaeetus* (not found in North America) (Johnsgard 1990:144). Talons with concave undersides.

Habitat: Anywhere in the North American continent where there are adequate nest trees, roosts, and feeding grounds. Always near open water (coasts, lakes, and large rivers).

It can be difficult to distinguish between the feathers of immature bald eagles and golden eagles. Pages 72 and 73 depict plumage differences between the species.

Skull length: 115—130 mm

Bill length: 51—60 mm (44—42% of skull length)

Feather lengths (typical)

Primary: 36—50 cm

Secondary: 33—34 cm

Tail: 34—39 cm





*Golden Eagle (GOEA)**Aquila chrysaetos*

Order Falconiformes, family Accipitridae, subfamily Accipitrinae

Specimen: Adult, sex undetermined

Buteo characteristics shared by golden eagles: Superciliary shield prominent, consisting of two pieces. Bill without the toothing and notching seen in falcons. Nostrils not circular and are without bony tubercle. Tarsometatarsus obviously shorter than tibiotarsus. (Coues 1903:678) Talons with concave undersides.

Golden eagle traits: Very large. Dark with golden feathers on crown and neck. Bill large, long, very robust. Bill is blackish near the tip and bluish near the base. Cere is yellow. Nostrils oval, oblique. Tarsus closely feathered all around to the toes. (Coues 1903:695) Outer and middle toes webbed at base. The combination of feathered tarsi and a wing length of at least 55 cm serve to separate this species from all other North American raptors (Johnsgard 1990:262).

Habitat: Mountains, foothills, and adjacent grasslands. Wintering grounds include shrub-steppe lands, wetlands, rivers, and estuaries.

It can be difficult to distinguish between the feathers of immature bald eagles and golden eagles. Pages 72 and 73 depict plumage differences between the species.

Skull length: 115—125 mm

Bill length: 36 mm (range not available) (~31% of skull length)

Feather lengths (typical)

Primary: 33 cm

Secondary: 30 cm

Golden eagle talon. The talon of the second toe (inner) is the largest of the foot. The concave underside (typical of diurnal raptors) forms sharp cutting edges.



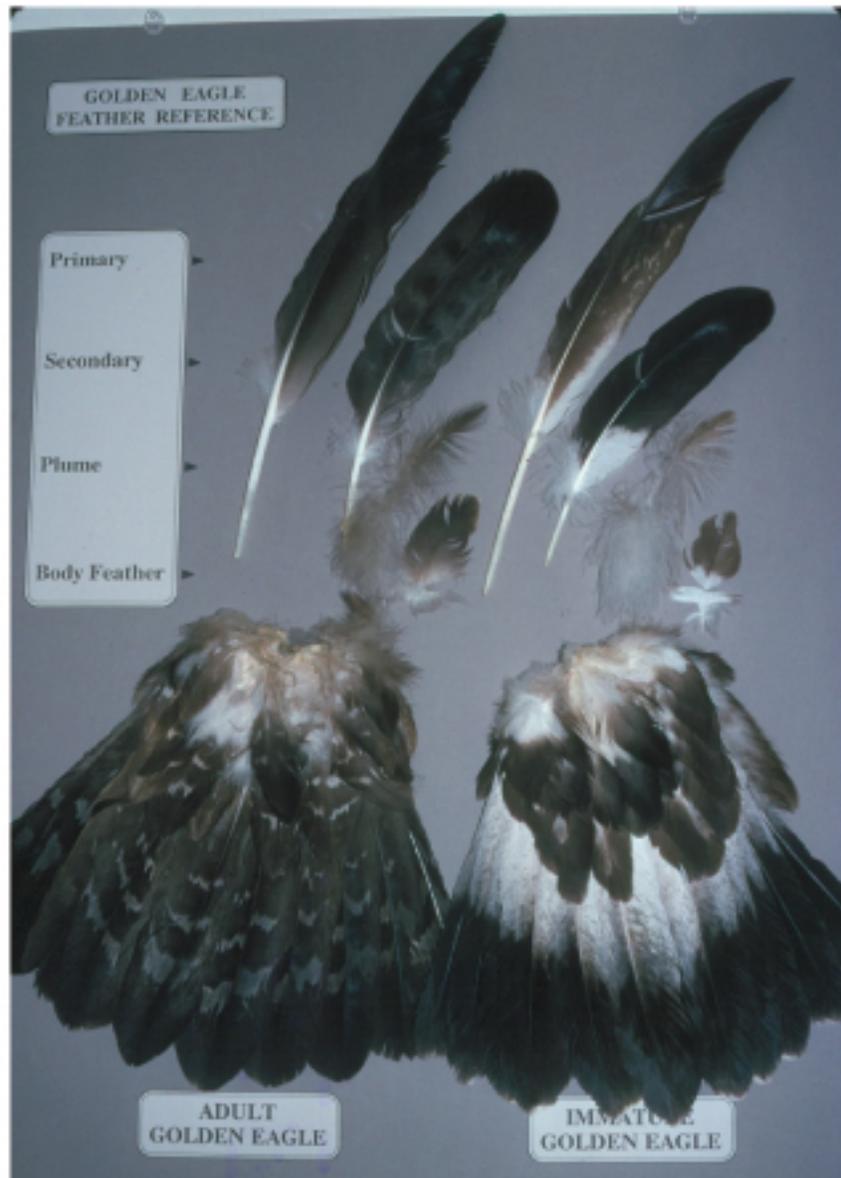
Joel Hummer



Feathers of Bald Eagle Compared



Feathers of Golden Eagle Compared



Falcons**American Kestrel (AMKE)**
Falco sparverius

Order Falconiformes, family Falconidae, subfamily Falconinae

Specimen: Adult male

Falcon traits: Nostrils are circular, with a central bony tubercle. The superciliary shield is present in one large piece. Upper bill has a tooth (sometimes two) near the tip of the cutting edge, and a corresponding notch in the mandible edge (these are features of the keratinous bill sheath and are not apparent when the sheath has decomposed). Tarsometatarsus is shorter than tibiotarsus. Middle toe is very long. (Coues 1903:633) Talons with concave undersides.

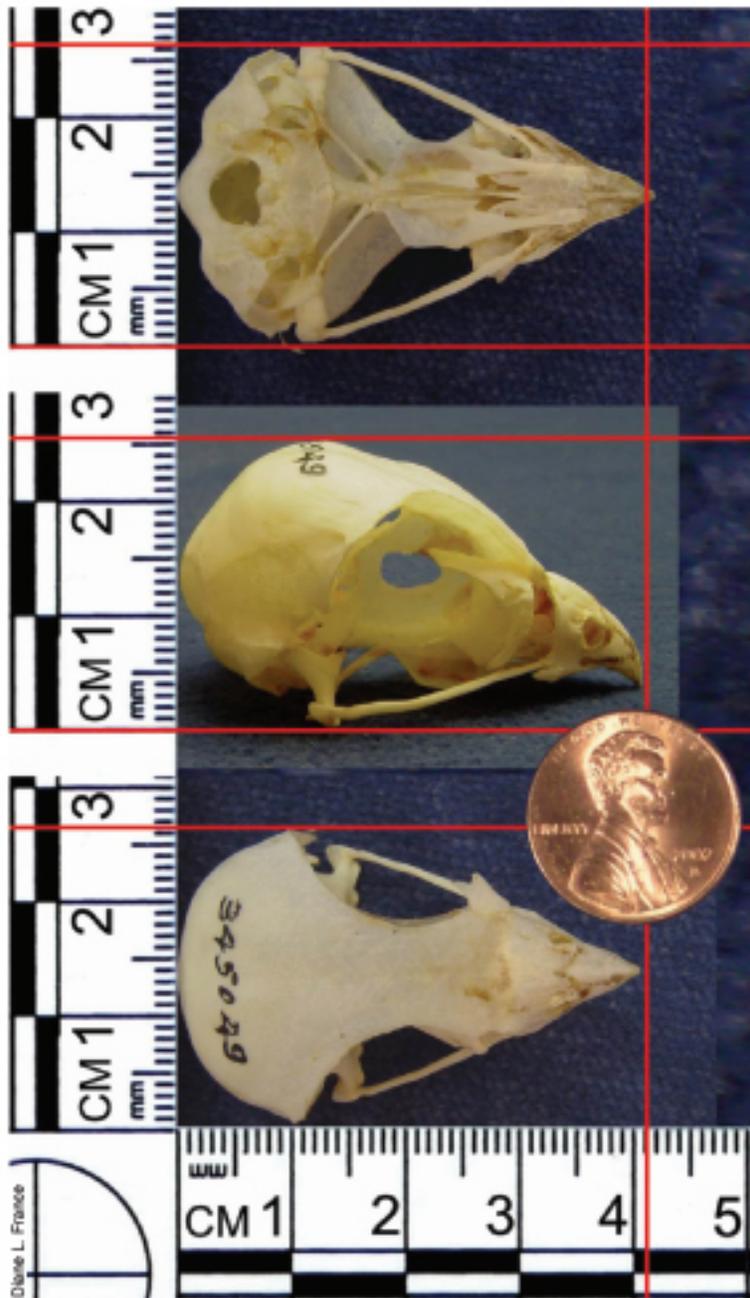
American kestrel traits: Smallest of the falcon species (wing length no more than 20.7 cm). Femur size smaller than merlin. Skull size similar to sharp-shinned hawk, but has circular nostril. Sexes different in plumage, but are nearly the same size.

Habitat: A wide variety of open habitats, including urban areas.

Skull length: 40—41 mm
Bill length: 12—14 mm
(29—34% of skull length)

Feather lengths (typical)
Primary: 13.7—16 cm
Secondary: 7—9 cm
Tail: 11.4—13.7 cm





*Peregrine Falcon (PEFA)**Falco peregrinus*

Order Falconiformes, family Falconidae, subfamily Falconinae

Specimen: Adult male

Falcon traits: Nostrils are circular, with a central bony tubercle. The superciliary shield is present in one large piece. Upper bill has a tooth (sometimes two) near the tip of the cutting edge, and a corresponding notch in the mandible edge (these are features of the keratinous bill sheath and are not apparent when the sheath has decomposed). Tarsometatarsus is shorter than tibiotarsus. Middle toe is very long. (Coues 1903:633) Talons with concave undersides.

Peregrine falcon traits: Cutting edge of upper bill is strongly toothed, and mandible is deeply notched. Toes extremely long. Tarsus not feathered. (Coues 1903:669) Very similar in size and shape to prairie falcon. This species may be identified by the combination of circular nostrils, a wing length of at least 30 cm, and the tenth (outermost) primary longer than the seventh and only slightly shorter than the longest (ninth) (Johnsgard 1990:302).

Habitat: Open country near cliffs, urban areas, coast.

Feather lengths (typical)

Primary: 17—27.6 cm

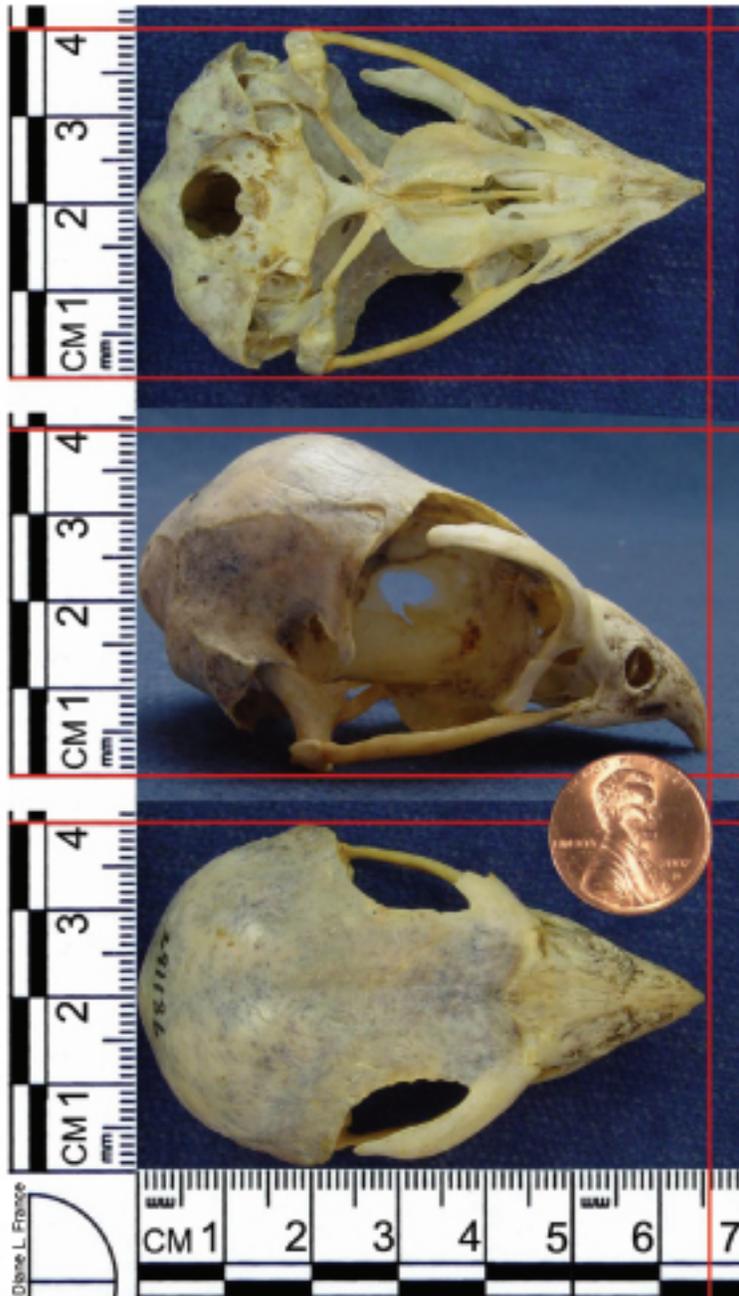
Secondary: 15—17 cm

Tail: 21 cm



Falcon traits: Circular nostril with central bony tubercle, tooth on sheath of upper bill, and notch on sheath of mandible.





Prairie Falcon (PRFA)
Falco mexicanus

Order Falconiformes, family Falconidae, subfamily Falconinae

Specimen: Adult male

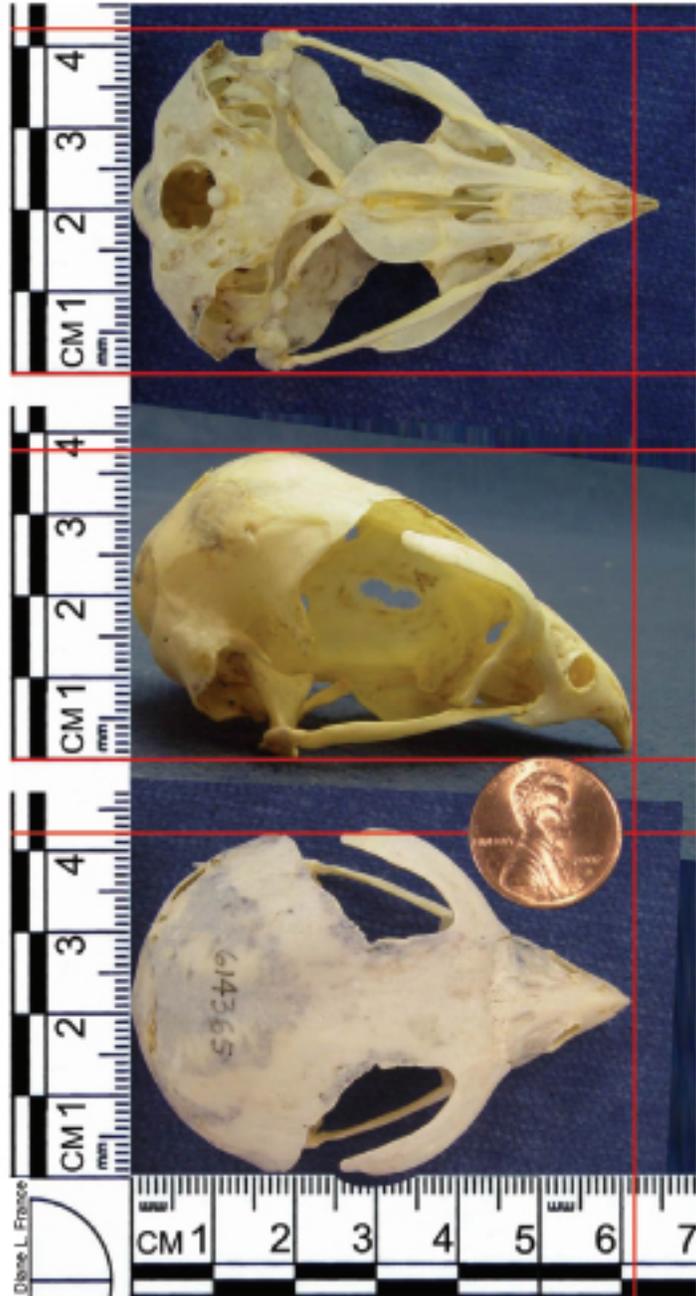
Falcon traits: Nostrils are circular, with a central bony tubercle. The superciliary shield is present in one large piece. Upper bill has a tooth (sometimes two) near the tip of the cutting edge, and a corresponding notch in the mandible edge (these are features of the keratinous bill sheath and are not apparent when the sheath has decomposed). Tarsometatarsus is shorter than tibiotarsus. Middle toe is very long. (Coues 1903:633) Talons with concave undersides.

Prairie falcon traits: Very similar in size and shape to peregrine falcon. The combination of circular nostrils, a wing length of 28.9—35.7 cm, and dark axillary feathers ("wing pits") serves to differentiate this species from all other North American raptors (Johnsgard 1990:324).



Habitat: Plains, grasslands, and other open country.

Prairie falcon feathers are very similar to those of the peregrine falcon, but are paler overall and more brownish than slate colored.

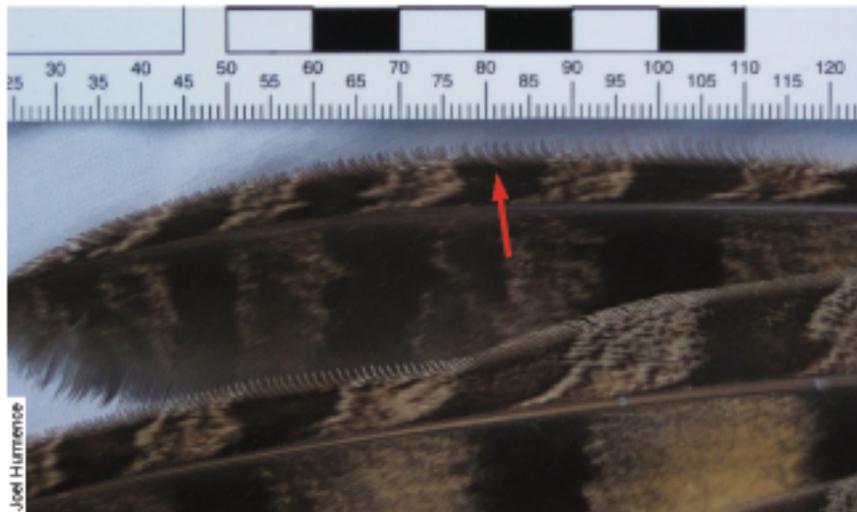


Owls

Order Strigiformes consists of two distinct families: Tytonidae (barn owls) and Strigidae (typical owls). These mostly nocturnal birds of prey have large, broad heads and large, forward-facing eyes. The cranium is wider and shorter than in Falconiformes. In owl skulls, the frontal bone (forehead area) rises markedly at the base of the bill. Ear openings in flesh are large, and notably asymmetric in some species. The tomia (cutting edges of the bill and mandible) are smooth in all species. Talons are round in cross section. The outer (fourth) toe is reversible, and shorter than the inner (second) toe. Owl primary feathers have comb-like fringe to reduce wing noise. Feet usually feathery or bristly to or on the toes. (Johnsgard 1988) Nostrils at edge of cere. The first joint of the middle toe is about as long as the second joint, but much shorter than the next-to-last joint. (Coues 1903:618-619)

In North American typical owls (Strigidae), the sternum is indented with four deep notches; a characteristic shared with woodpeckers and some gulls and shorebirds (Gilbert, Martin, Savage 1996).

Other differences between the two owl families are noted below and on the following pages.



Primary feathers of great horned owl. Note the serrated leading edge, a comb-like fringe characteristic of owl primary feathers.



Skull of boreal owl showing asymmetry in the position of ear openings.

Feathered toes of great horned owl.

Barn owls—sternum not notched; furculum fused to sternum; middle talon comb-like; facial disk heart-shaped.

Typical owls—sternum notched; furculum not fused to sternum; middle talon has sharp-edged groove on inner face; facial disk circular.



Sternum of great horned owl (left) and ferruginous hawk (right). Note the deep notches characteristic of all owls but the barn owl.

*Barn Owl (BNOW)**Tyto alba*

Order Strigiformes, family Tytonidae

Specimen: Adult male

Owl traits: A rise in the frontal bone (forehead area) above the base of the bill. Cranium is wide and relatively short. Ear openings in flesh are large. Bill cutting edges are smooth. Outer toe (fourth) is reversible. Talons are round in cross section. (Johnsgard 1988:18)

Barn owl traits: Skull and beak are long relative to typical owls, as are the legs. Skull is symmetrical in shape, but fleshy ear openings are asymmetrical (Norberg 2002:330). The eyes of barn owls are smaller and set farther apart than typical owls. The furcula is fused to the sternum, and the sternum is not deeply notched as in typical owls. Legs/feet are long and sparsely feathered down to, but not including the toes. The inner (second) toe is same length as middle (third) toe. This is the only North American owl with a heart-shaped facial disk, and the only one in which the talon of the middle toe (third) is pectinated (comb-like) (Johnsgard 1988:96, 99).

Habitat: Open farmlands, grasslands, deserts, and suburban areas.

Skull length: 66—81 mm

Bill length: 24—32 mm (32—39% of skull length)

Feather lengths (typical)

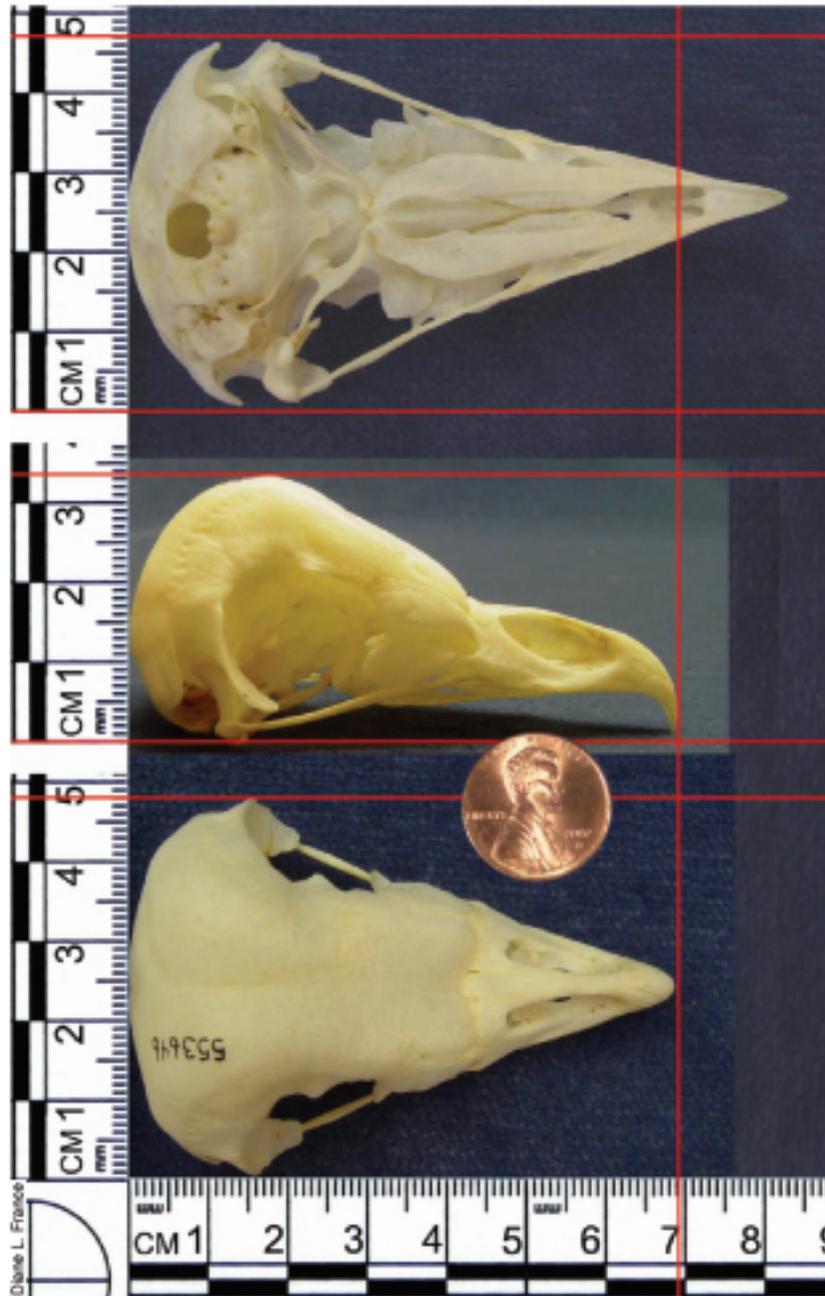
Primary: 21—27 cm

Secondary: 17—18 cm



The sheath of the middle talon of the barn owl has a comb-like ridge (shown: underside view of middle talon).





*Long-eared Owl (LEOW)**Asio otus*

Order Strigiformes, family Strigidae.

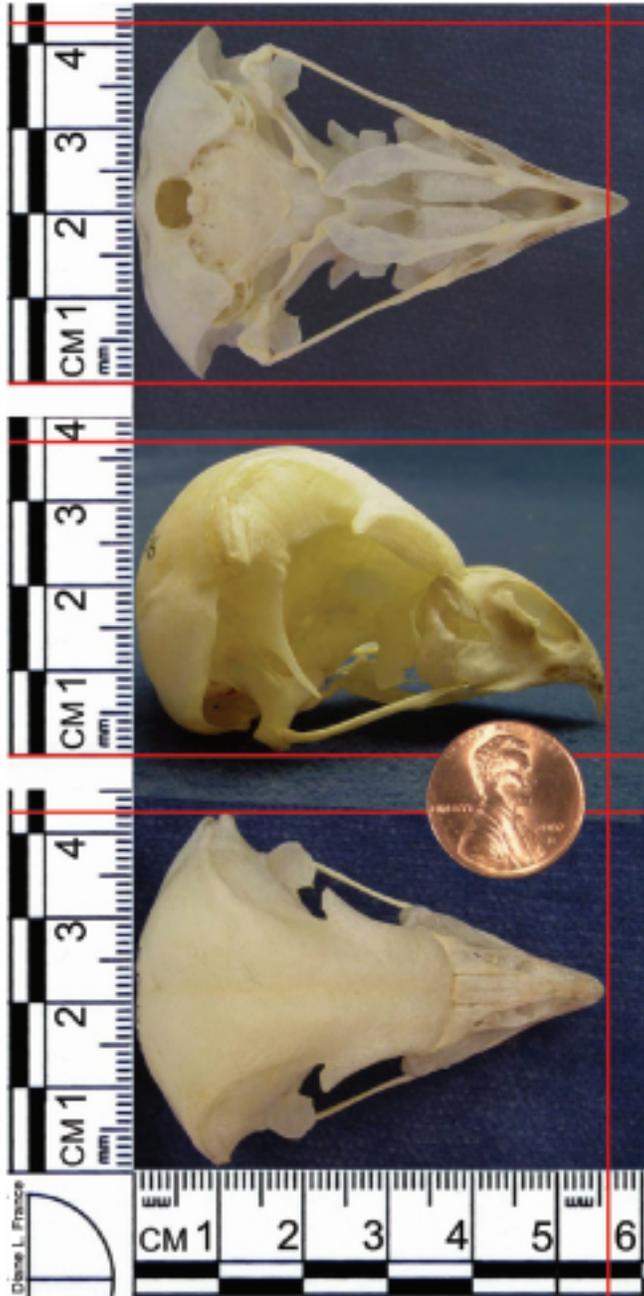
Specimen: Adult female

Typical owl traits: A bulging rise in the frontal bone (forehead area) above the base of the bill. Cranium is wide and relatively short. Feathered facial disk is rounded. Ear openings in flesh are large. Bill cutting edges are smooth. The furcula is not attached to sternum. The sternum has four deep notches. Legs relatively short. The inner toe is much shorter than the middle toe. Outer toe is reversible. Talons are round in cross section, and talon of middle toe has sharp-edged groove along inner face. (Coues 1903:618-619, Johnsgard 1988:18,96)

Long-eared owl traits: A slender owl with distinctive long "ear tufts." Other identifying marks are the reddish brown facial disk with narrow black rim markings around the orange-colored eyes, and a contrasting lighter "moustache" and "eyebrow" area around the bill (Johnsgard 1988:204). Skull is symmetrical in shape. Ear asymmetry achieved by a skin septum that is oriented in a different position in each ear (Norberg 2002:337-338). Bill and talons are black. Feet and toes are completely feathered. Overall color is brownish gray, and breast feathers include vertical streaks (great horned owl breast feathers have only horizontal streaks).

Habitat: Woods near open fields and marshes.

The short-eared owl is similar in size and has a similar skeleton, but is usually found in much more open country than the long-eared owl. The long-eared owl is more typically found in areas where at least some trees are present.



*Short-eared Owl (SEOW)**Asio flammeus*

Order Strigiformes, family Strigidae.

Specimen: Adult, sex undetermined

Typical owl traits: A bulging rise in the frontal bone (forehead area) above the base of the bill. Cranium is wide and relatively short. Feathered facial disk is rounded. Ear openings in flesh are large. Bill cutting edges are smooth. The furcula is not attached to sternum. The sternum has four deep notches. Legs relatively short. The inner toe is much shorter than the middle toe. Outer toe is reversible. Talons are round in cross section, and talon of middle toe has sharp-edged groove along inner face. (Coues 1903:618-619, Johnsgard 1988:18,96)

Short-eared owl traits: Short, inconspicuous "ear tufts." Has yellow eyes surrounded by fairly thick blackish rims but a whitish outer facial disk, as compared with thinner blackish rims and more rusty outer disk in the long-eared owl (Johnsgard 1988:213). Skull is symmetrical in shape. Ear asymmetry achieved by a skin septum that is oriented in a different position in each ear (Norberg 2002:337-338). Feet and toes are completely feathered. The "ear tufts" are small and might difficult to discern on carcasses.

Habitat: Open fields, marshes, dunes, and grasslands.

The short-eared owl is similar in size and appearance to the long-eared owl, and has a similar skeleton, but is usually found in much more open country. The long-eared owl is found in areas where at least some trees are present.

Feather lengths (typical)

Primary: 20 cm

Secondary: 15—16 cm

Tail: 14—15 cm

Like the great horned owl and other typical owls, the short-eared owl has a sharp-edged groove along the inner face of its middle talon.





Western Screech-owl (WESO)
Megascops kennicotti

Order Strigiformes, family Strigidae.

Specimen: Adult, sex undetermined

Typical owl traits: A bulging rise in the frontal bone (forehead area) above the base of the bill. Cranium is wide and relatively short. Feathered facial disk is rounded. Ear openings in flesh are large. Bill cutting edges are smooth. The furcula is not attached to sternum. The sternum has four deep notches. Legs relatively short. The inner toe is much shorter than the middle toe. Outer toe is reversible. Talons are round in cross section, and talon of middle toe has sharp-edged groove along inner face. (Coues 1903:618-619, Johnsgard 1988:18,96)

Western screech-owl traits: Small owl with feathered "ear tufts," brown to gray in color. Skull symmetrical in shape. Nearly identical to eastern screech-owl (*Megascops asio*). Bill almost always black, with a whitish tip. The dorsal (back) pattern is one of linear black streaks, and the ventral (front) patterning has thinner crossbars than in the Eastern screech-owl (Johnsgard 1988:121). Feet and toes are feathered in northern populations but bristled in southern deserts.

Habitat: Woods, swamps, parks, suburban areas, and deserts.

Skull length: 51—54 mm (Eastern Screech-owl)

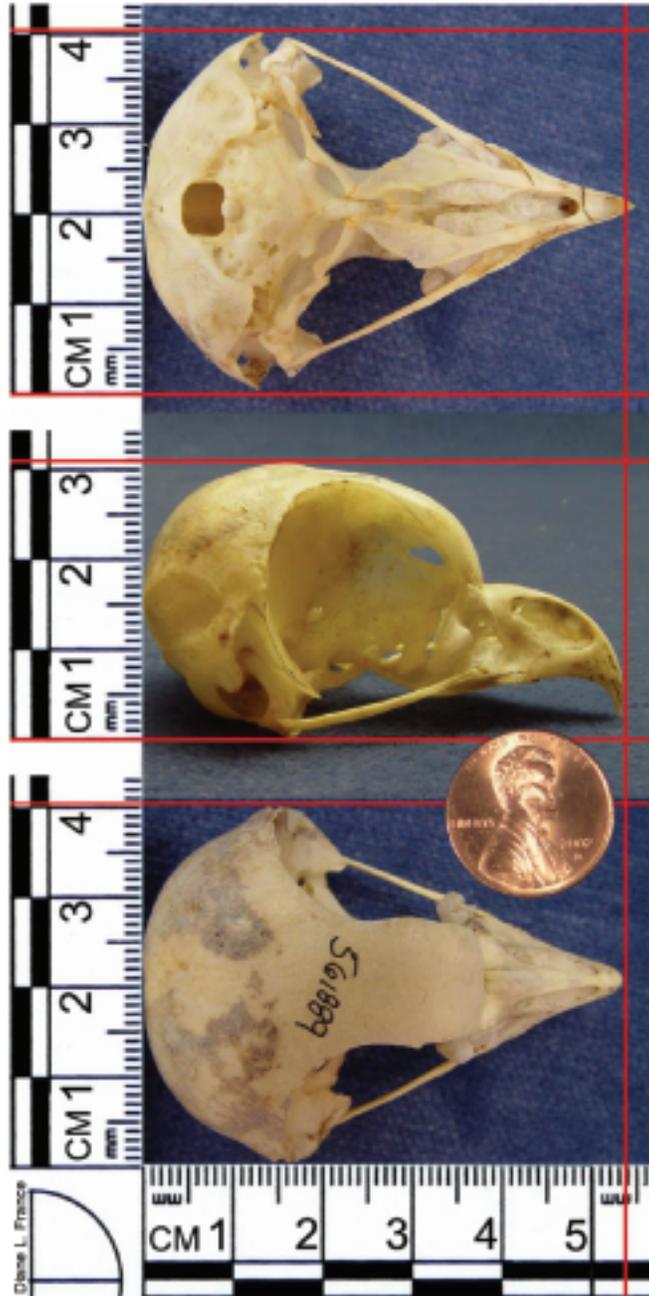
Bill length: 16—18 mm (31—33% of skull length) (Eastern Screech-owl)

Feather lengths (typical for Eastern Screech-owl)

Primary: 21—22 cm

Secondary: 15—17 cm

Tail: 16—17 cm



Great Horned Owl (GHOW)
Bubo virginianus

Order Strigiformes, family Strigidae.

Specimen: Adult, sex undetermined

Typical owl traits: A bulging rise in the frontal bone (forehead area) above the base of the bill. Cranium is wide and relatively short. Feathered facial disk is rounded. Ear openings in flesh are large. Bill cutting edges are smooth. The furcula is not attached to sternum. The sternum has four deep notches. Legs relatively short. The inner toe is much shorter than the middle toe. Outer toe is reversible. Talons are round in cross section, and talon of middle toe has sharp-edged groove along inner face. (Coues 1903:618-619, Johnsgard 1988:18,96)



Great horned owl traits: Large owl with prominent "ear tufts." Skull symmetrical in shape. Ears are symmetrical (Norberg 2002:335). Feet and toes feathered. Heaviest brown North American owl (over 1200 g) (Johnsgard 1988:130).

Habitat: Extremely varied; woods, deserts, suburban areas.

Skull length: 84—94 mm
Bill length: 41—44 mm
(47—48% of skull length)

Feather lengths (typical)
Primary: 26 cm
Secondary: 18—24 cm
Tail: 22—24 cm



The middle talon sheath of the great horned owl, like those of other typical owls, features a sharp-edged groove along its inner side.



*Burrowing Owl (BUOW)**Athene cunicularia*

Order Strigiformes, family Strigidae.

Specimen: Adult, sex undetermined

Typical owl traits: A bulging rise in the frontal bone (forehead area) above the base of the bill. Cranium is wide and relatively short. Feathered facial disk is rounded. Ear openings in flesh are large. Bill cutting edges are smooth. The furcula is not attached to sternum. The sternum has four deep notches. Legs relatively short. The inner toe is much shorter than the middle toe. Outer toe is reversible. Talons are round in cross section, and talon of middle toe has sharp-edged groove along inner face. (Coues 1903:618-619, Johnsgard 1988:18,96)

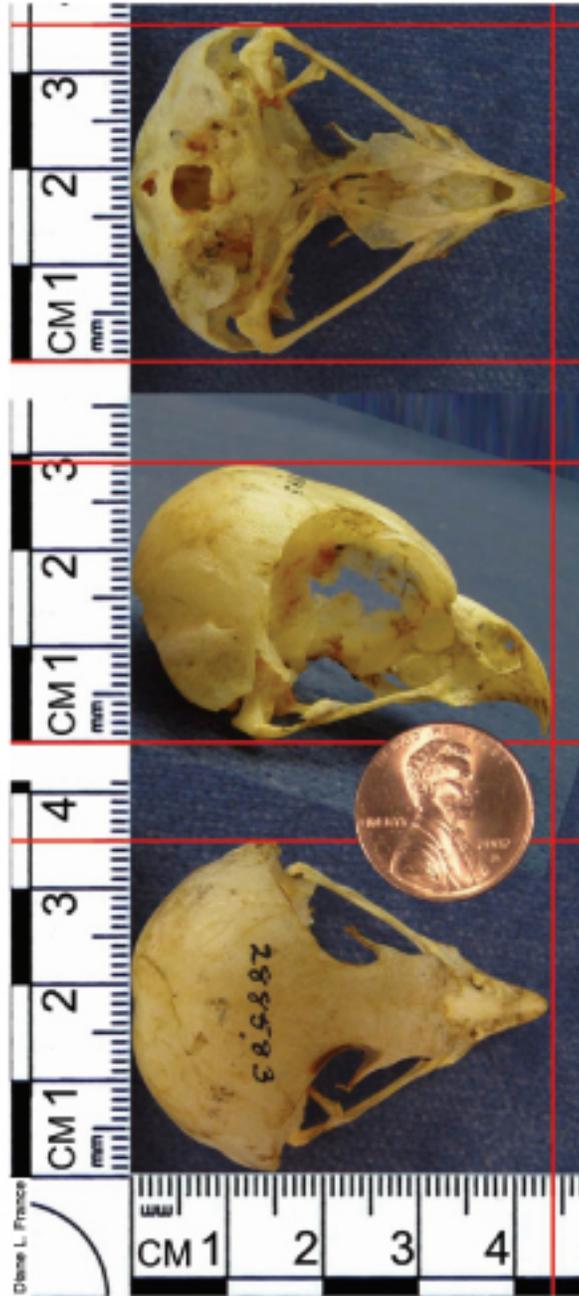
Burrowing owl traits: No "ear tufts." Color generally yellowish-brown with speckles of white. Skull symmetrical in shape. Lower tarsometatarsus and toes appear naked but are actually bristled. The very long feet (tarsometatarsus more than twice as long as the middle toe) and generally small body (wing under 185 mm) serve to separate this species from all other North American owls (Johnsgard 1988:172).

Habitat: Open plains, grasslands, desert scrub.

Feather lengths (typical)

Primary: 21—25 cm

Secondary: 23—24 cm



Corvids

American Crow (AMCR)
Corvus brachyrhynchos

Order Passeriformes, family Corvidae

Specimen: Adult female

Corvid traits: As those of other passerines, the corvid skull is long and narrow compared to those of raptors. The bill is not hooked, and does not have a bump or rise near the tip as seen in vultures. Corvids have a bifurcated manubrium on the sternum.

American crow traits: Medium-sized corvid. All black with squared tail. Similar in appearance to the skull of the common raven, but not as large. Wing: 27.2 to 34.1 cm, tail: 14.7-19.9 cm (Pyle 1997:310)

Habitat: Widespread. Mostly in open country but increasingly numerous in cities.

Skull length: 76—91 mm

Bill length: 44—50 mm (54-56% of skull length)

Feather lengths (typical)

Primary: 22—24 cm

Secondary: 16—18 cm



Because their skulls are very similar, the black-billed magpie (left and right above) can be mistaken for a small American crow. Magpie limb bones, however, are shorter than the ranges for American crows. The remains of white belly feathers provide a definite clue.



*Common Raven (CORA)**Corvus corax*

Order Passeriformes, family Corvidae.

Specimen: Adult, sex undetermined

Corvid traits: As those of other passerines, the corvid skull is long and narrow compared to those of raptors. The bill is not hooked, and does not have a bump or rise near the tip as seen in vultures. Corvids have a bifurcated manubrium on the sternum.

Common raven traits: Large corvid. All black with wedge-shaped tail. Similar to American crow, but significantly larger. Very thick bill, shaggy throat feathers. Wing: 38.3 to 46.8 cm, tail: 20.6-26.3 cm (Pyle 1997:314)

Habitat: Mountains, forests, canyons, deserts, coast. Also moving into cities in some regions.

Skull length: 112—117 mm

Bill length: 68—77 mm (60—66% of skull length)



Broken sternum of a common raven. In corvids, the manubrium of the sternum is bifurcated (divided into two branches).





Joel Hummer





Joel Hummance



Joel Hummerose





Pellets (Castings)

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After the digestion process, birds regurgitate compressed packets of food remains called pellets or castings. These pellets may contain bits of hair, bones, feather scraps, fish scales, small mammal skulls, insect parts, and so forth. Most bird species in North America are capable of producing pellets, but those of larger species are larger, last longer and are more likely to be found in the field. An abundance of these pellets indicates a perch regularly used by raptors. Note that mammal scat may also be present. Mammal scat can be distinguished from bird pellets because scat is held together by a kind of cement that can become powdery when dry.

Pellet size and composition are variable, and can give clues to the bird species or group (eagle, hawk, falcon, etc.) that produced them. Pellets found at roosting sites, can also be examined to determine the bird's diet. This information can be of additional help in identifying the species of bird, when combined with habitat and perch location.

Owls typically swallow their prey whole including items such as fur, feathers, and bones. Hawks usually tear off pieces of prey, which also includes fur, feathers, and bones. When the pellet is formed, the bones are wrapped inside fur or feathers. It is important to note that although some species of hawks and owls produce similar sized pellets, hawk pellets typically will have fewer small bones. This is because hawks have stronger stomach acids than owls, and bones are more completely digested by hawks (Elbroch, Marks, and Boretos 2001:171). Owl pellets are also typically longer in length than in width.

Red-tailed Hawk Pellets



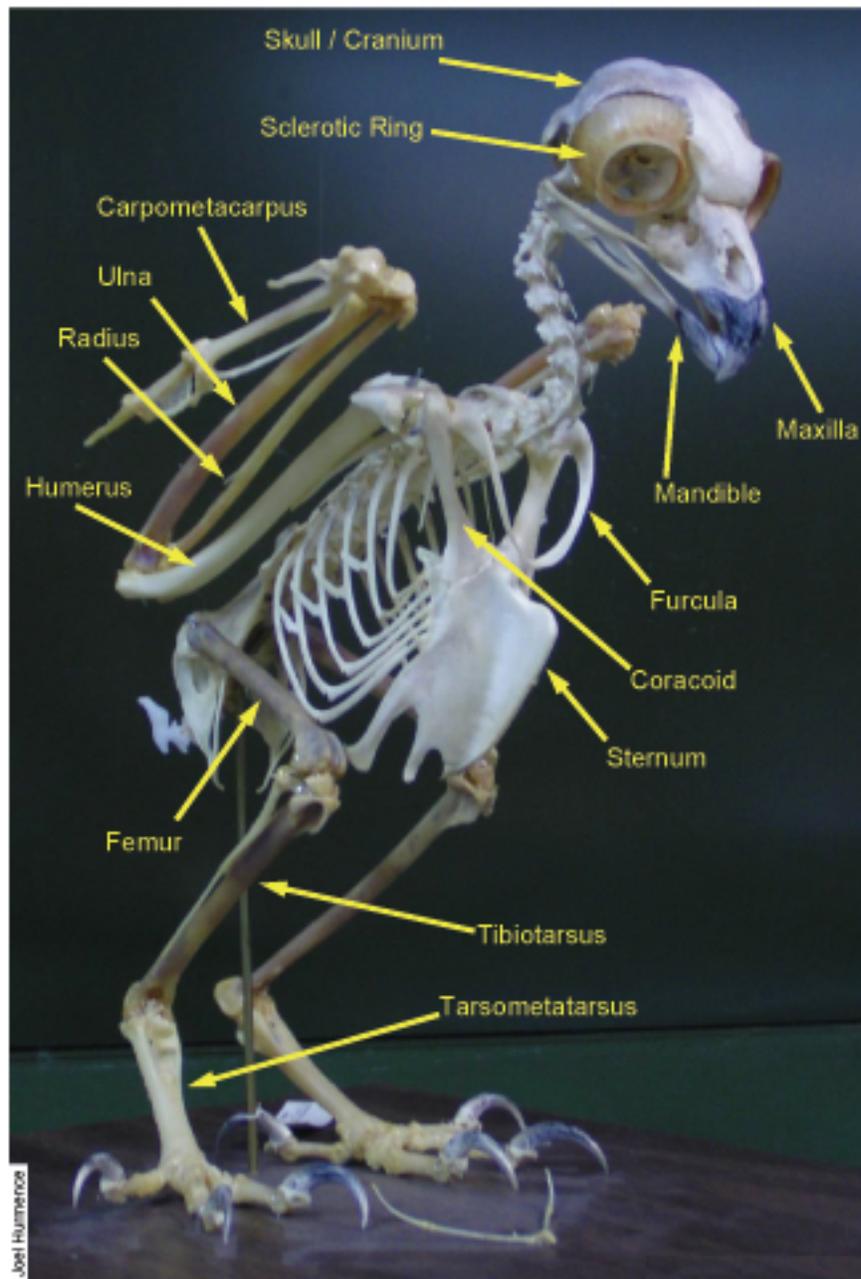
Great Horned Owl Pellets



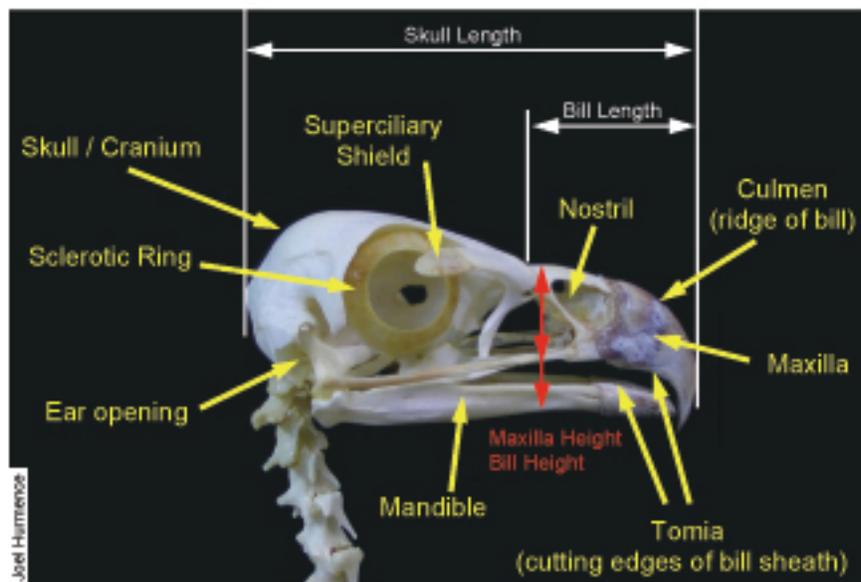
Pellets of red-tailed hawk (left) compared to those of great horned owl (right). Note the bones clearly visible in the pellets of the owl.

Pellets (Castings)

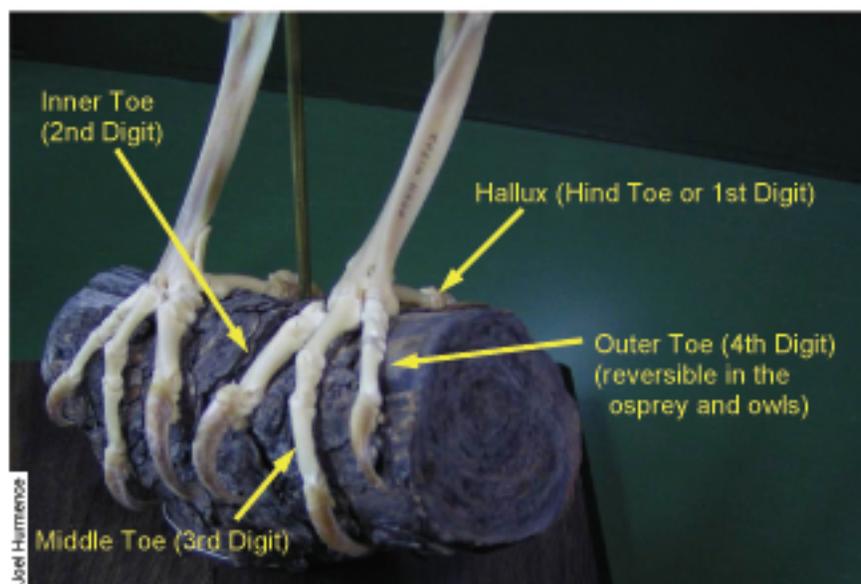


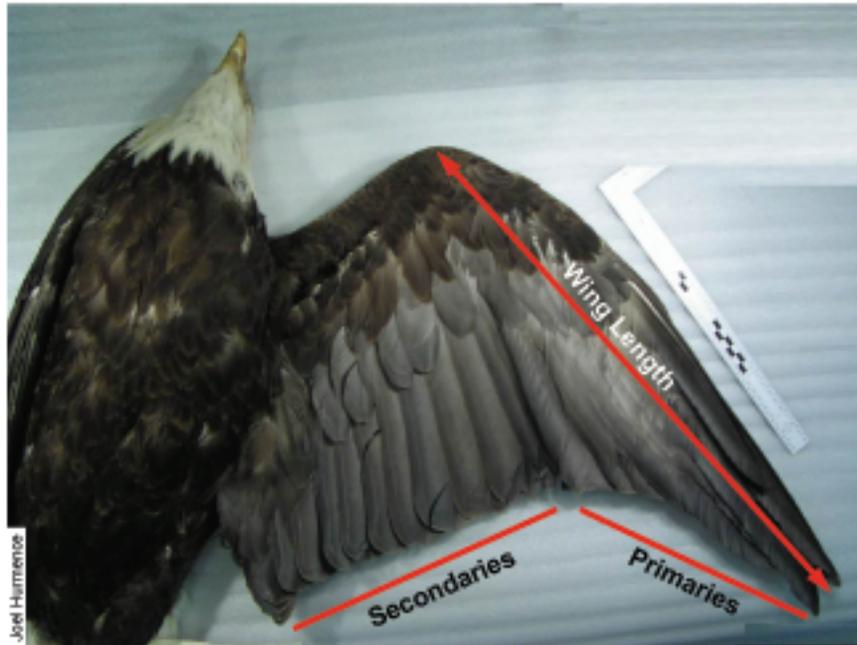


Joel Hummer



Facing page: Great horned owl. Above: Golden eagle. Below: Red-tailed hawk.





Above: Wing length is measured along the folded, flattened wing, from the bend of the wrist to the tip of the longest primary (pictured: adult bald eagle).

Left: Tail length is measured from the tip of the longest tail feathers to the point where the central tail feathers emerge from the skin (pictured: immature golden eagle).

Right: primary feather of bald eagle.

Notch

Emargination

Inner Web

Outer Web

Shaft



Glossary of Terms

- ax-i-al**— Located on, around, or in the direction of an axis. The axial skeleton refers to the skull, backbone, sternum, and ribs.
- bi-fur-ca-ted**—Divided into two branches.
- bill**—Beak; refers to maxilla (upper mandible) and (lower) mandible. Bill length is the horizontal distance from the base of the maxilla to the tip. Bill height (depth) is the vertical distance from the lower edge of the mandible to the top edge of the maxilla, measured at either the base of the bill or the front edge of nostril (as so noted). For specimens without mandible, maxilla height may be noted.
- car-pal**—Of or relating to the wrist.
- car-po-met-a-car-pus**—The bone of a bird's wing formed by fusion of the carpal and metacarpal (wrist and hand) bones.
- cau-dal**—Of, towards, or near the tail or hind parts.
- cor-a-coid**—Large bone of the shoulder, forming a near-vertical pillar between the sternum, and the furcula and scapula.
- cere**—Fleshy region at the base of the maxilla of the bill that surrounds the nostrils.
- clav-i-cle**—Also called collarbone. Either of two slender bones that extend from the sternum to the scapula.
- cor-tex**—The outer layer of a body structure.
- cor-ti-cal bone**—Also called compact bone. Bone tissue that is relatively dense, having few spaces or canals; bone tissue forming the exterior surface of a bone (cortex).
- cra-ni-al**—Of or relating to the skull or cranium.
- cul-men**—The central ridge along the top of the bill, lengthwise. The culmen length (chord) of a bird's skull is the straight line measured from the base of the bill (at union with skull) to the tip of the bill. (Culmen length may also be defined as from edge of feathers or edge of cere to tip, for specimens with those features intact.)
- dor-sal**—Near the upper surface; towards the back.
- fe-mur**—Also called thighbone. A bone of the leg situated below the pelvis.

- fur-cu-la**—The wishbone; made up of the two clavicles, providing an area of attachment for the breast muscles.
- gape**—The lateral distance across the mouth at the base of the opened bill; also refers to the skin associated with the open mouth, as in "gape color."
- go-nys**—The lower outline of a bird's lower bill.
- hal-lux**—The hind toe; first digit of foot.
- hu-mer-us**—The long bone of the upper arm or forelimb, extending from the shoulder to the elbow.
- il-i-um**—The uppermost and widest of the three bones constituting either of the lateral halves of the pelvis.
- is-chi-um**—The lowest of the three major bones that constitute each half of the pelvis.
- lores**—Area between the cere and front of the eyes.
- lum-bar**—Of, near, or situated in the part of the back and sides between the lowest ribs and the pelvis.
- man-di-ble**—The lower part of the bill (beak). Sometimes used in plural to refer to both upper and lower parts of the bill.
- max-il-la**—The upper part of the bill (beak).
- pel-vis**—Rigid platform for the attachment of the leg and tail muscles; each half is formed by the fusion of the ilium, ischium, pubis; the two halves are fused together with the synsacrum.
- pneu-ma-tized**—Describes bird bones which are hollow and filled with air spaces connected to the respiratory system. The skull, humerus, sternum, furcula, coracoid, vertebrae, femur, and pelvis are pneumatized in adults of most species.
- pri-mar-ies**—Flight feathers of the wing attached to the hand (carpometacarpus) and digits.
- py-go-style**—The plate of bones forming the posterior end of the vertebral column in most birds. The tail bones.
- pu-bis**—A long, thin bone fused with the ilium and ischium to form each half of the pelvis.
- ra-di-us**—A long, prismatic, slightly curved bone. The shorter and thicker of the two forearm bones, located to the side of the ulna.

- ram-pho-the-ca**—The horny sheath covering the bill of birds.
- sa-crum**—A triangular bone made up of five fused vertebrae and forming the posterior section of the pelvis.
- se-con-dar-ies**—Flight feathers of the wing attached to the forearm (unla).
- sep-tum**—Dividing partition between two tissues or cavities.
- scler-o-tic ring**—Circular bony structure that encircles the eye.
- ster-num**—Also called breastbone. A long flat bone in most vertebrates that is situated along the ventral midline of the thorax and articulates with the ribs.
- su-per-cil-i-a-ry shi-eld**—Bony plate projecting above eye socket that acts to protect and shade the eye. Also called the superciliare.
- syn-sa-crum**—Bone formed by the fusion of the following vertebrae: some thoracic, the lumbar, the sacral, and some caudal vertebrae.
- tail length**—Measured from the tips of the longest tail feathers to the point where the central tail feathers emerge from the skin.
- tar-so-met-a-tar-sus**—A compound bone between the tibia and the toes of a bird's leg, formed by fusion of the tarsal and metatarsal bones. Sometimes called simply tarsus (plural: tarsi).
- tho-rac-ic**—Of, relating to, or situated in or near the thorax. Thoracic vertebrae are those with rib attachments.
- tib-i-o-tar-sus**—A long bone in the leg of a bird between the femur and the tarsometatarsus, consisting of the tibia fused with the proximal bones of the tarsus. Sometimes called simply tibia.
- tra-ber-cu-lae**—Fine projections and struts of bone forming a network in cancellous bone (also called spongy bone, trabecular bone).
- to-mia**—The cutting edges of the sheath covering the upper and lower bill of a bird. Singular: tomium.
- tu-ber-cle**—A protuberance on a bone.
- ul-na**—The larger bone extending from the elbow to the wrist. Plural: ulnae.
- un-ci-nate**—Bent at the end like a hook; unciform.
- ven-tral**—Toward the bottom; towards the belly.

ver-te-bra—Any of the bones forming the spinal column. Plural: vertebrae.

wing length—Measured from the bend (wrist) of the folded wing to the tip of the longest primary feather, usually done with the feathers flattened, unless stated as being the chord (unflattened) distance.

SPECIES ABBREVIATIONS

AMCR	American Crow
AMKE	American Kestrel
BAEA	Bald Eagle
BBMA	Black-billed Magpie
BCNH	Black-crowned Night-Heron
BDOW	Barred Owl
BLVU	Black Vulture
BNOW	Barn Owl
BOOW	Boreal Owl
BUOW	Burrowing Owl
CALC	California Condor
COHA	Cooper's Hawk
CORA	Common Raven
EASO	Eastern Screech-owl
EUST	European Starling
FEHA	Ferruginous Hawk
GBHE	Great Blue Heron
GHOW	Great Horned Owl
GOEA	Golden Eagle
GYRF	Gyr Falcon
HRSB	Harris's Hawk
LEOW	Long-eared Owl
MERL	Merlin
MIKI	Mississippi Kite
NOGO	Northern Goshawk
NOHA	Northern Harrier
NPGO	Northern Pygmy-owl
OSPR	Osprey
PEFA	Peregrine Falcon
PRFA	Prairie Falcon
RLHA	Rough-legged Hawk
RSHA	Red-shouldered Hawk
RTHA	Red-tailed Hawk
SEOW	Short-eared Owl
SSHA	Sharp-shinned Hawk
SWHA	Swainson's Hawk
TUVU	Turkey Vulture
WESO	Western screech-owl
WTKI	White-tailed Kite (formerly black-shouldered kite)

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